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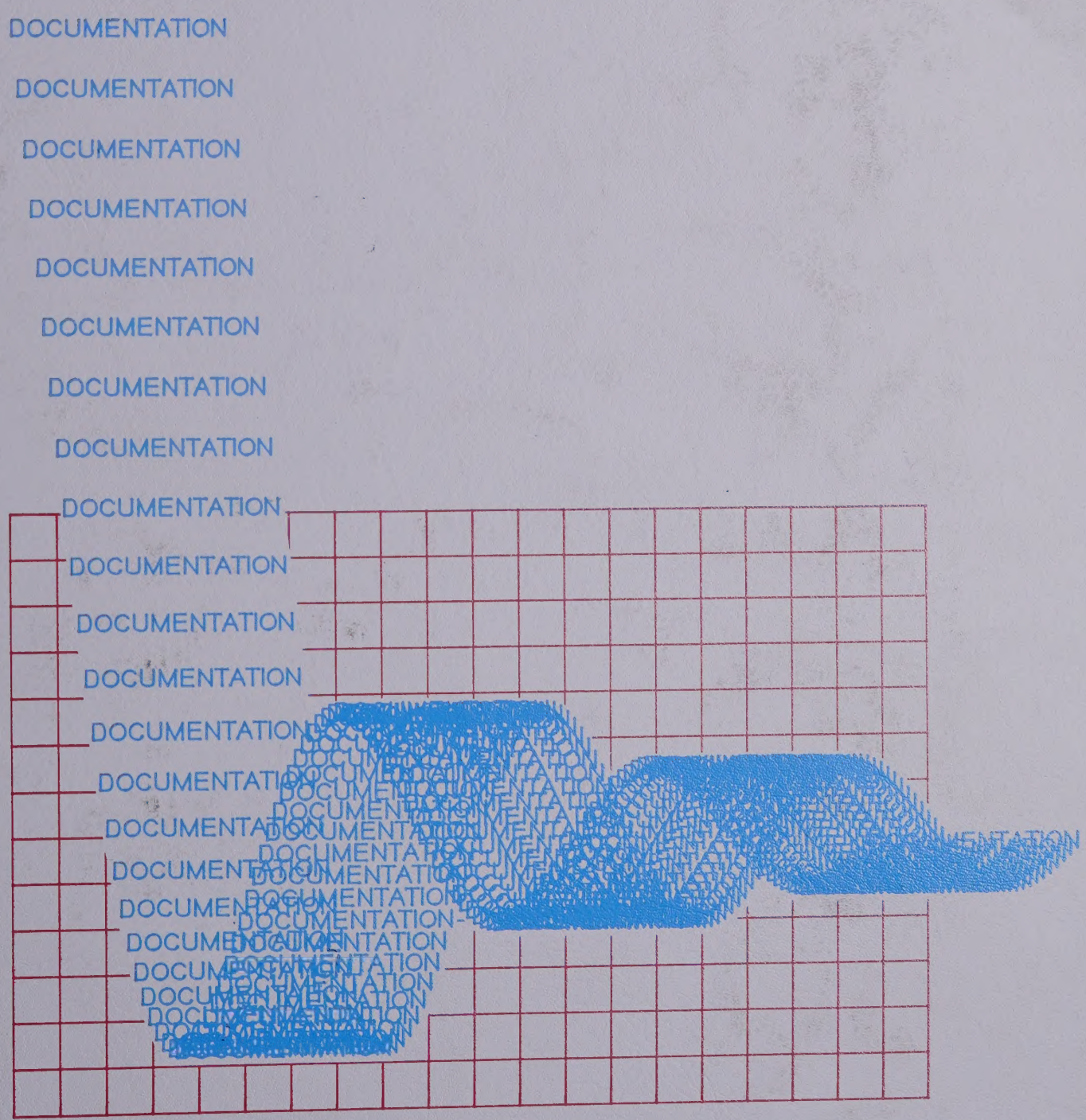
DOCUMENTATION
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ROHDE&SCHWARZ

Test and Measurement
Division

Operating Manual

SIGNAL GENERATOR

R&S SML01

1090.3000.11

R&S SML02

1090.3000.12

R&S SML03

1090.3000.13

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Tabbed Divider Overview

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Safety Instructions
Certificate of Quality
EC Certificate of Conformity
List of R&S Representatives

Short Tutorial About How to Use the Manual

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Signal Generator R&S SML

Economy at its best

- 9 kHz to 1.1 GHz/2.2 GHz/3.3 GHz
- SSB phase noise:
  <–122 dBc (1 Hz)
  (at f = 1 GHz, Δf = 20 kHz)
- Setting times <10 ms
- High level accuracy
  (deviation <0.5 dB
  at levels >–120 dBm)
- High reliability through electronic attenuator
- Digital frequency and level sweep
- AM/FM/φM
- Optional pulse modulator with integrated pulse generator
- 3-year calibration cycle

ROHDE&SCHWARZ

Unequalled universality

Frequency

- 9 kHz to 1.1 GHz/2.2 GHz/3.3 GHz
- 0.1 Hz frequency resolution

Level

- –140 dBm to +13 dBm (+19 dBm overrange)
- High level accuracy (deviation <0.5 dB, at levels >–120 dBm)
- Level setting without overshoots
- Electronic attenuator
- Non-interrupting level setting

Spectral purity

- SSB phase noise <–122 dBc (1 Hz), typ. –128 dBc (1 Hz) (f = 1 GHz, carrier offset 20 kHz)
- Broadband noise <–140 dBc (1 Hz), typ. –150 dBc (1 Hz) (f = 1 GHz, carrier offset >2 MHz)

Speed

- Setting times <10 ms for frequency and level

Modulation

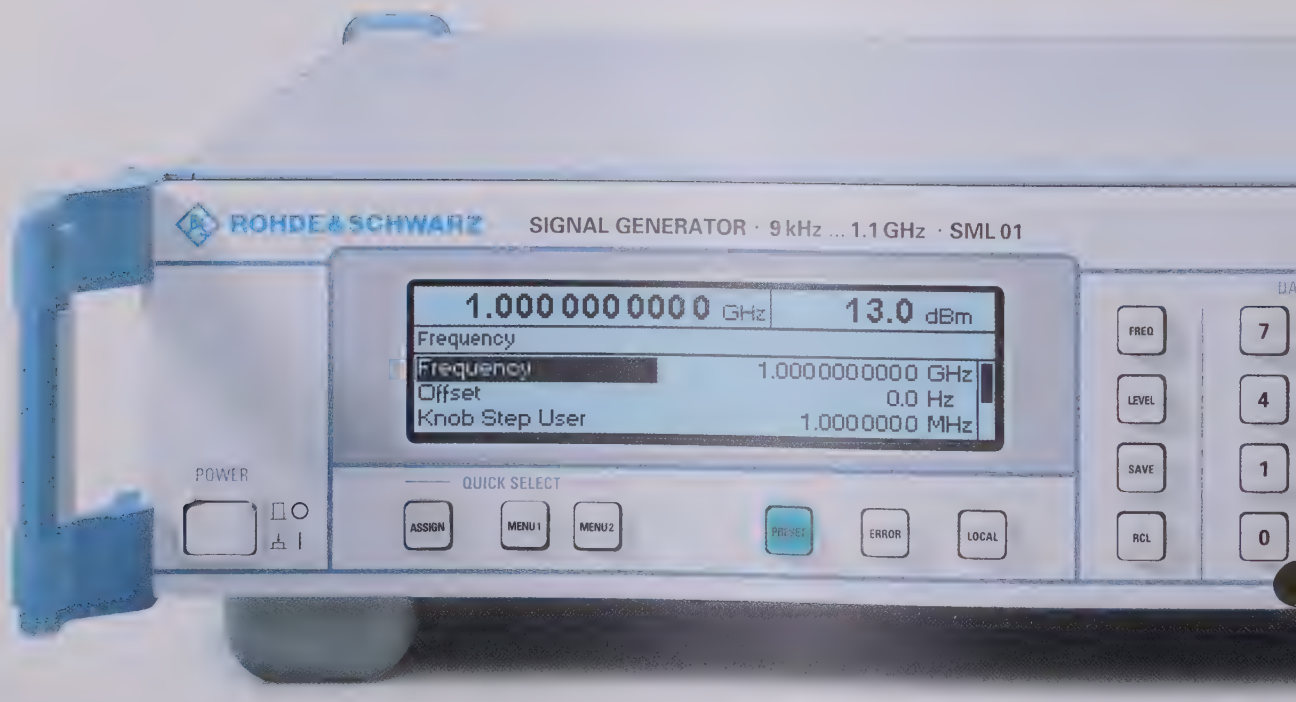
- AM/FM/φM as standard
- Simultaneous AM, FM/φM and pulse modulation
- Optional pulse modulator with integrated pulse generator (R&S SML-B3)

Low cost of ownership

- 3-year calibration cycle
- Low purchase price
- High reliability through electronic attenuator (wear-free)
- Service-friendly (continuous selftest, access to internal test points)
- Options OCXO (R&S SML-B1) and pulse modulator (R&S SML-B3) retrofittable

Size

- Compact size: 427 mm x 88 mm x 450 mm
- Low weight: <8.5 kg



Applications

Lab and R&D: versatile

High spectral purity
Thanks to its low phase noise R&S SML is ideally suited to replace LOs.

Versatile modulation modes
R&S SML in conjunction with the optional Pulse Modulator R&S SML-B3 handles all analog types of modulation. AM, FM/φM and pulse modulation can be used simultaneously. TDMA signals or amplitude variations at FM, for example, can thus be simulated.

High and precise output level
R&S SML has plenty of power in reserve so level loss produced by the test setup can be easily compensated. Its high output level makes R&S SML an ideal source for driving high-level mixers.

Excellent modulation characteristics
The DC-coupled FM allows the R&S SML to be used as an accurate VCO.

Example: receiver measurements

- Sensitivity measurements require a signal generator with high level accuracy. This is particularly true at low output levels. With its sophisticated calibration technique, R&S SML features high level accuracy (<0.5 dB at levels >–120 dBm).
- Squelch measurements call for continuous level setting. Non-interrupting level variation by typ. 30 dB makes R&S SML the ideal choice for squelch measurements.

R&S SML offers all features required of a state-of-the-art general-purpose signal generator: wide frequency range, large variety of modulation functions and high reliability – at an extremely attractive price. The fields of application of R&S SML are virtually unlimited in development, servicing or production where it is used as a flexible signal source in automatic test systems. R&S SML benefits both from our long-standing experience in the field of signal generators and the latest technology. Its uses are as versatile as its functionalities.

- Low spurious, low broadband noise and above all excellent SSB phase noise are prerequisites for using a signal generator as an interference source. With typ. –128 dBc (1 Hz) SSB phase noise (at f = 1 GHz, Δf = 20 kHz), spurious suppression of typ. –76 dBc and broadband noise of typ. –150 dBc (1 Hz), R&S SML easily meets even the most exacting requirements.
- The mechanical design of R&S SML ensures excellent RF shielding of its casing. This is particularly important for measurements on highly sensitive receivers with built-in antenna such as pagers.

Applications (continued)

Servicing: robust, compact, lightweight

Mobility
R&S SML is lightweight and compact and therefore very easy to transport.

Flexible control
In service environments, an IEC/IEEE interface is not always available for controlling the generator. This is no problem for R&S SML since it can also be driven via a standard RS-232-C interface.

Protection against overvoltage
The integrated overvoltage protection of the RF input protects the R&S SML against very high external voltages such as may occur during transceiver measurements.

Production: fast, accurate, reliable

Accuracy
Measurement uncertainty can be split into the contribution from the instrument and that introduced by the test setup. With a smaller uncertainty of the generator, greater tolerances can be allowed for the setup. If the small level deviation of the analyzer is used to allow for higher DUT tolerances, the result will be a marked reduction in manufacturing rejects – an advantage that pays off immediately.

Speed
Speed is of prime importance in production. And this is exactly one of the strong points of R&S SML, with a setting time <10 ms for frequency and level.

Reliability
A signal generator used in production must have high reliability. R&S SML meets this requirement for example through the use of a completely wear-free electronic attenuator. Should a fault nevertheless occur, the continuous self-diagnosis of R&S SML prevents expensive erroneous measurements.

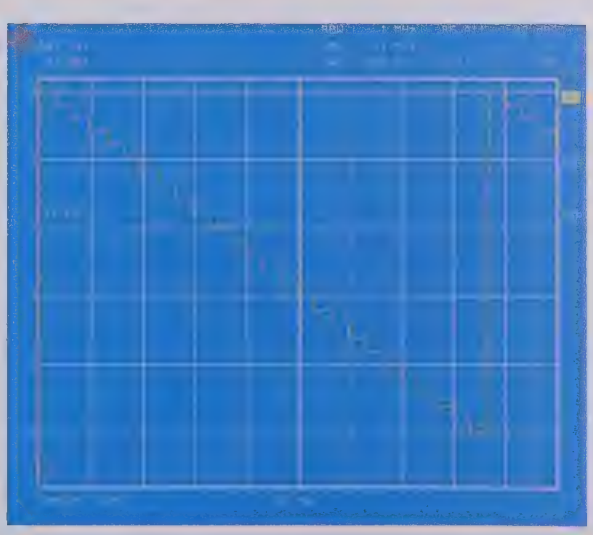
Output level
Production test systems, in which the signal is taken to the DUT via switches and cables, cause level losses which can be easily compensated by the high output power of R&S SML.

Dimensions
Space is often at a premium in production. The compact size of R&S SML makes it ideal for use in such environments.

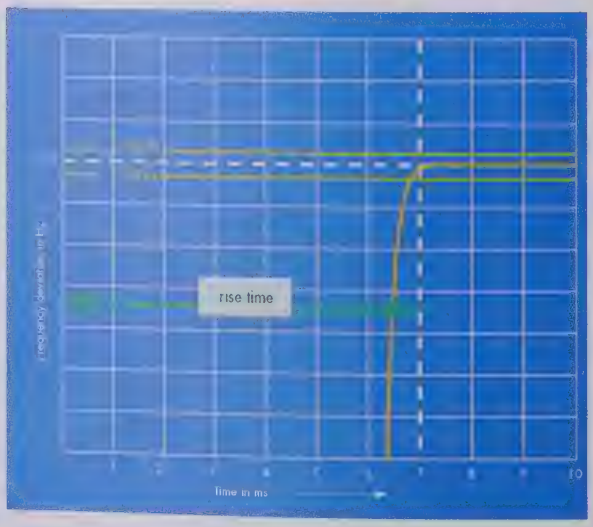
Example: component test

- To obtain reliable information on component quality, high level accuracy and precise reproducibility of the output level are called for. R&S SML fully meets these requirements thanks to the level deviation of <0.5 dB (at levels >–120 dBm) and high reproducibility.
- With unrivalled short times (<10 ms) for frequency and level setting, R&S SML enables fast testing and is ideal for use in production.
- Overshoots in case of level change may damage or destroy the DUT. This cannot happen with R&S SML since it operates without any overshoots.

Level sweep within 25 dB range



Settling upon frequency change from 100 MHz to 1 GHz



EMS measurements

Non-interrupting level setting without overshoots

EMS measurements call for non-interrupting level setting which should moreover be performed without any overshoots. R&S SML operates free of overshoots and offers a wide dynamic range of typ. 30 dB for non-interrupting level variation (with Attenuator Mode Fixed).

Wide frequency range

R&S SML has a lower frequency limit of 9 kHz as standard and so fully covers the frequency range required for EMC measurements.

Reference source

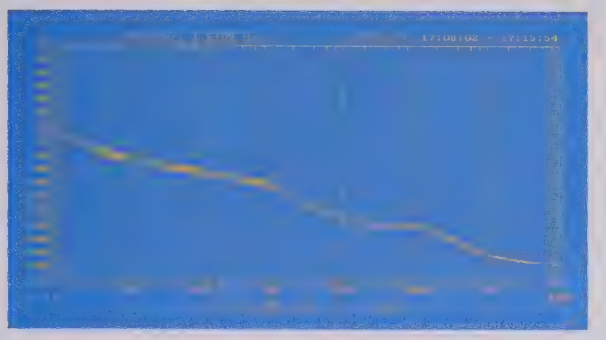
R&S SML offers the option of selecting the mode of frequency generation. In the Extended Divider Range mode, the RF signal is generated by frequency division. The excellent values obtained in this mode for SSB phase noise are comparable with the high-grade crystal oscillators normally used as reference sources from 10 MHz to 30 MHz.

Compared to crystal oscillators, R&S SML provides the following benefits:

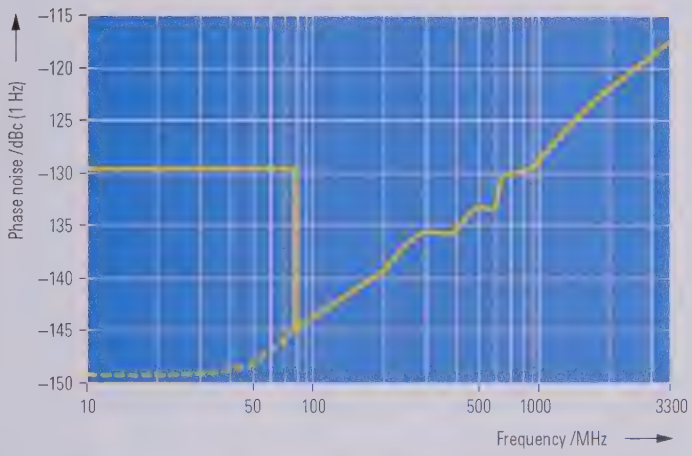
- Frequency can be set in 0.1 Hz steps and synchronized to an external reference
- All functions can be remotely controlled via the IEC/IEEE bus or serial interface

EasyWheel

- One-hand operation with EasyWheel
- All settings simple and self-explanatory
- High-contrast LCD
- User-assignable menu keys
- Online help including IEC/IEEE-bus commands



Typical SSB noise at 1 GHz (with OCXO option R&S SML-B1)



Typical SSB phase noise versus carrier frequency (carrier offset 20 kHz); dashed line: Extended Divider Range mode

Offset from carrier	SSB phase noise, typical values
1 Hz	–95 dB
10 Hz	–120 dB
100 Hz	–130 dB
1 kHz	–138 dB
10 kHz	–148 dB

SSB phase noise at 9.5 MHz output frequency, extended divider range activated, 1 Hz measurement bandwidth

Simply select the desired menu with the spin-wheel and click the button to open the submenu

Specifications

Specifications apply under the following conditions:
15 minutes warmup time at ambient temperature, specified environmental conditions met, calibration cycle adhered to, and total calibration performed.
Data designated "nominal" apply to design parameters and are not tested.
Data designated "overrange" are not warranted.
Warranted specs do not apply to the Extended Divider Range mode.

Frequency

Range	9 kHz to 1.1 GHz
R&S SML01	9 kHz to 1.1 GHz
R&S SML02	9 kHz to 2.2 GHz
R&S SML03	9 kHz to 3.3 GHz
Resolution	0.1 Hz
Setting time (for an offset of $<1x10^{-7}$ or <90 Hz for f ≤76 MHz) after IEC/IEEE-bus delimiter	<10 ms

Reference frequency

	Standard	Option R&S SML-B1
Aging (after 30 days of operation)	$<1x10^{-6}$/year	$<1x10^{-7}$/year or $<5x10^{-10}$/day
Temperature drift (0 °C to 55 °C)	$<1x10^{-6}$	$<2x10^{-8}$
Output for internal reference		
Frequency	10 MHz	
Output voltage, V rms, sinewave	>0.5 V into 50 Ω	
Source impedance	50 Ω	
Input for external reference		
Frequency	10 MHz	
Permissible frequency drift	$5x10^{-6}$	
Input voltage, V rms, sinewave	0.5 V to 2 V into 50 Ω	
Input impedance	50 Ω	

Spectral purity

Spurious signals	
Harmonics (for f>100 kHz)[1]	
R&S SML01	<–30 dBc at levels ≤+10 dBm
R&S SML02/R&S SML03	<–30 dBc at levels ≤+8 dBm
Subharmonics	
f ≤1.1 GHz	none
f >1.1 GHz	<–50 dBc
Nonharmonics (carrier offset >10 kHz)	
f ≤1.1 GHz	<–70 dBc
f >1.1 GHz to 2.2 GHz	<–64 dBc
f >2.2 GHz to 3.3 GHz	<–58 dBc
Broadband noise[2] (f = 1 GHz, carrier offset >2 MHz, 1 Hz bandwidth)	<–140 dBc, typ. –150 dBc
SSB phase noise (f = 1 GHz, 20 kHz carrier offset, 1 Hz bandwidth)	<–122 dBc, typ. –128 dBc
Spurious FM, rms (f = 1 GHz)	
0.3 kHz to 3 kHz	<4 Hz, typ. 1 Hz
0.03 kHz to 20 kHz	<10 Hz, typ. 3 Hz
Spurious AM, rms (0.03 kHz to 20 kHz)	<0.02%

Level

Range	–140 dBm to +13 dBm[2] (overrange +19 dBm)
Resolution	0.1 dB
Level accuracy[2][3] (level >–120 dBm)	
R&S SML01 (for f>100 kHz)	<0.5 dB
R&S SML02/SML03	
100 kHz to ≤ 2 GHz	<0.5 dB
f >2 GHz	<0.9 dB
Frequency response at 0 dBm[2][3]	
R&S SML01 (for f>100 kHz)	<0.5 dB, typ. 0.3 dB
R&S SML02/R&S SML03	
100 kHz to ≤ 2 GHz	<0.7 dB
f >2 GHz	<1.0 dB
Characteristic impedance	50 Ω
VSWR	
R&S SML01	<1.5
R&S SML02/03	
100 kHz to 1.5 GHz	1.6
f >1.5 GHz	2.3
Setting time (IEC/IEEE bus), f >100 kHz	<10 ms, typ. 5 ms
Non-interrupting level setting (for f>100 kHz)[4]	20 dB, overrange 30 dB
	safeguards unit against externally applied RF power and DC voltage (50 Ω source)
Max. permissible RF power	
f ≤2.2 GHz	50 W
f >2.2 GHz	25 W
Max. permissible DC voltage	35 V

[illegible]

Frequency range	0.1 Hz to 1 MHz
Resolution	0.1 Hz
Frequency accuracy	as for reference frequency + 2.4×10^{-3} Hz
Frequency response (up to 500 kHz, level >100 mV)	<0.5 dB
THD (up to 100 kHz, level 4 V, R_L = 600 Ω)	<0.1%
Open-circuit voltage V_p (LF connector)	1 mV to 4 V
Resolution	1 mV
Setting accuracy (at 1 kHz)	1% of V_P + 1 mV
Output impedance	approx. 10 Ω
Frequency setting time (after reception of last IEC/IEEE-bus character)	<10 ms
	AM, FM/φM and pulse modulation

[illegible]

Operating modes	internal, external AC/DC, internal/external two-tone
Modulation depth	0% to 100%, settable modulation depth continuously decreasing between +7 dBm and +13 dBm[6] while adhering to AM specifications; a status message is output when modulation depth is too high
Resolution	0.1%
Setting accuracy at 1 kHz (m <80 %)[7]	<4% of reading +1%
AM distortion at 1 kHz	
m = 30%	<1%
m = 80%	<2%
Modulation frequency range (<3 dB)	DC/10 Hz to 50 kHz

Incidental φM at AM (30%), AF = 1 kHz	<0.2 rad
Modulation input EXT	
Input impedance	>100 kΩ
Input voltage V_p for set modulation depth	1 V

[illegible] modulation

Operating modes	internal, external AC/DC, internal/external two-tone
Frequency deviation	
9 kHz to 76 MHz	0 MHz to 1 MHz
>76 MHz to 151.3125 MHz	0 kHz to 125 kHz
>151.3125 MHz to 302.625 MHz	0 kHz to 250 kHz
>302.625 MHz to 605.25 MHz	0 kHz to 500 kHz
>605.25 MHz to 1.2105 GHz	0 MHz to 1 MHz
>1.2105 GHz to 1.818 GHz	0 MHz to 2 MHz
>1.818 GHz to 2.655 GHz	0 MHz to 3 MHz
>2.655 GHz to 3.300 GHz	0 MHz to 4 MHz
Resolution	<1% of set deviation, minimum 10 Hz
Setting accuracy (at AF = 1 kHz)	<4% of reading + 20 Hz
FM distortion (at AF = 1 kHz and 50% of max. deviation)	<0.2%, typ. 0.1%
Modulation frequency range (<3 dB), standard/wide	DC/10 Hz to 100 kHz/500 kHz
Incidental AM (at AF = 1 kHz, f >10 MHz, 40 kHz deviation)	<0.1%
Stereo modulation at 40 kHz useful deviation, AF = 1 kHz, RF = 87 MHz to 108 MHz	
Crosstalk	>50 dB
S/N ratio unweighted, rms	>70 dB
S/N ratio weighted, rms	>70 dB
Distortion	<0.2%, typ. 0.1%
Carrier frequency offset at FM DC	typ. 0.1% of set deviation
Modulation input EXT	
Input impedance	>100 kΩ
Input voltage V_p for set deviation (nominal value)	1 V

Phase modulation

Operating modes	internal, external AC/DC, internal/external two-tone
Phase deviation[8]	
9 kHz to 76 MHz	0 rad to 10 (2) rad
>76 MHz to 151.3125 MHz	0 rad to 1.25 (0.25) rad
>151.3125 MHz to 302.625 MHz	0 rad to 2.5 (0.5) rad
>302.625 MHz to 605.25 MHz	0 rad to 5 (1) rad
>605.25 MHz to 1.2105 GHz	0 rad to 10 (2) rad
>1.2105 GHz to 1.818 GHz	0 rad to 20 (4) rad
>1.818 GHz to 2.655 GHz	0 rad to 30 (6) rad
>2.655 GHz to 3.300 GHz	0 rad to 40 (8) rad
Resolution	<1%, min. 0.001 rad
Setting accuracy at AF = 1 kHz	<4% of reading + 0.02 rad
Phase distortion (at AF = 1 kHz and 50% of maximum deviation)	<0.2%, typ. 0.1%
Modulation frequency range (–3 dB), standard/wide	DC/10 Hz to 100 kHz/500 kHz
Modulation inputs EXT	
Input impedance	>100 kΩ
Input voltage V_p for set deviation (nominal value)	1 V

Pulse modulation (with option R&S SML-B3)

Operating modes	internal, external
On/off ratio	>80 dB
Rise/fall time (10%/90%)	<20 ns, typ. 10 ns,
Pulse repetition frequency	0 MHz to 2.5 MHz
Pulse delay	typ. 50 ns
Video crosstalk (V_p)	<30 mV
Modulation input PULSE	
Input level	TTL level (HCT)
Input impedance	10 kΩ or 50 Ω, selectable with internal link

Pulse generator (with option R&S SML-B3)

Operating modes	automatic, externally triggered, external gate mode, single pulse, double pulse, delayed pulse (externally triggered)
Active trigger edge	positive or negative
Pulse period	100 ns to 85 s
Resolution	5 digits, min. 20 ns
Accuracy	$<1 \times 10^{-4}$
Pulse width	20 ns to 1 s
Resolution	4 digits, min. 20 ns
Accuracy	$<(1 \times 10^{-4} + 3$ ns)
Pulse delay	20 ns to 1 s
Resolution	4 digits, min. 20 ns
Accuracy	$<(1 \times 10^{-4} + 3$ ns)
Double-pulse spacing	20 ns to 1 s
Resolution	4 digits, min. 20 ns
Accuracy	$<(1 \times 10^{-4} + 3$ ns)
Trigger delay	typ. 50 ns
Jitter	<10 ns
PULSE/VIDEO output	TTL signal ($R_L \geq 50$ Ω)

Sweep

	digital in discrete steps
RF sweep, AF sweep	
Operating modes	automatic, single-shot, manually or externally triggered, linear or logarithmic
Sweep range	user-selectable
Step width (lin)	user-selectable
Step width (log)	0.01% to 100%
Level sweep	
Operating modes	automatic, single-shot, manually or externally triggered, logarithmic
Sweep range	user-selectable
Step width (log)	user-selectable
Step time	10 ms to 1 s
Resolution	0.1 ms

Memory for device settings

Storable settings	100

Remote control

System	IEC 625 (IEEE 488) and RS-232
Command set	SCPI 1995.0
Connector	Amphenol, 24-pin and 9-pin
IEC/IEEE-bus address	0 to 30
Interface functions	SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT1, C0

[1] With option R&S SML-B3 only for f > 20 MHz
[2] With Attenuator Mode Auto.
[3] Temperature range 20 °C to 30 °C.
[4] With Attenuator Mode Fixed.
[5] With Attenuator Mode Auto, f ≥100 kHz.
[6] +5 dBm to 11 dBm at f ≤5 MHz, f >3 GHz.
[7] With option R&S SML-B3 only for f >10 MHz.
[8] Values in brackets apply to wide modulation bandwidth.

General data

Temperature loading	
Specs complied with between	0 °C and 55 °C; meets IEC68-2-1 and IEC68-2-2
Storage temperature range	–40°C to +70°C
Climatic resistance	
Damp heat	95% relative humidity at +25 °C/ +40 °C cyclically; meets IEC68-2-3
Mechanical resistance	
Vibration, sinusoidal	5 Hz to 150 Hz, max. 2 g at 55 Hz, max. 0.5 g between 55 Hz and 150 Hz, meets IEC68-2-6, IEC1010-1 and MIL-T-28800D, class 5
Vibration, random	10 Hz to 300 Hz, acceleration 1.2 g (rms)
Shock	40 g shock spectrum, meets MIL-STD-810D and MIL-T-28800D, class 3/5
Electromagnetic compatibility	meets EN 50081-1 and EN 50082-1 (EMC directive of EU)
Susceptibility to radiated interference	10 V/m
Power supply	100 V to 120 V (AC), 50 Hz to 400 Hz, 200 V to 240 V (AC), 50 Hz to 60 Hz, autoranging, max. 150 VA
Safety	meets DIN EN 61010-1, IEC 1010-1, UL 3111-1, CSA 22.2 No. 1010-1
Dimensions (W x H x D)	427 mm x 88 mm x 450 mm
Weight	8.5 kg when fully equipped

Ordering information

Signal Generator	R&S SML01	1090.3000.11
	R&S SML02	1090.3000.12
	R&S SML03	1090.3000.13
Accessories supplied		power cable, user manual
Options		
Reference Oscillator OCXO	R&S SML-B1	1090.5790.02
Pulse Modulator	R&S SML-B3	1090.5403.02*)
Rear Connectors for AF, RF	R&S SML-B19	1090.5303.02*)
Recommended extras		
Service Kit	R&S SML-Z2	1090.5203.02
19" Rack Adapter	R&S ZZA-211	1096.3260.00
Transport Bag	R&S ZZT-214	1109.5119.00
Service Manual, Modules		1090.3123.24

*) Factory-fitted only.

Certified Environmental System
ISO 14001
REG. NO 1954

Certified Quality System
ISO 9001
DQS REG. NO 1954

ROHDE&SCHWARZ

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Stereo/RDS Coder R&S SML-B5

- Stereo coder with analog and digital audio inputs
- RDS signals with user-programmable content
- Traffic area identification
- Switchable stereo pilot tone
- Versatile test system consisting of R&S SML with R&S SML-B5 and Audio Analyzer R&S UPL

ROHDE&SCHWARZ

Specification

The specifications apply to RF frequencies in the range 66 MHz to 110 MHz.

Stereo modes	
Internal with modulation generator	L, R, R = L, R = –L
External analog (via L and R inputs) or external digital (via S/P DIF input)	L, R, R = L, R = –L, R ≠ L internal generation of ARI/RDS signals, 5 user-selectable RDS data sets, simultaneous generation of MPX, ARI and RDS signals possible
MPX frequency deviation	0 Hz to 80 kHz
Resolution	10 Hz
L, R signal	
AF Frequency range	20 Hz to 15 kHz
AF Frequency response (referred to 500 Hz) AF = 20 Hz to 40 Hz AF = 40 Hz to 15 kHz	 <0.3 dB <0.2 dB
Stereo crosstalk (at AF = 1 kHz)	>45 dB
Distortion (at 67.5 kHz MPX frequency deviation, AF = 1 kHz)	<0.1%, 0.05% typ.
S/N ratio[1] (stereo/RDS signal) ITU-R weighted (quasi-peak) ITU-R unweighted (rms) A-weighted (rms)	 >60 dB >70 dB >70 dB
Preemphasis	off, 50 µs, 75 µs
Pilot tone	
Frequency	19 kHz ±2 Hz
Deviation Resolution	0 Hz to 10 kHz 10 Hz
Phase (relative to 38 kHz phase) Resolution	0° to ±5° 0.1°
ARI/RDS subcarrier frequency	57 kHz ±6 Hz
ARI frequency deviation Resolution	0 Hz to 10 kHz 10 Hz
RDS frequency deviation Resolution	0 Hz to 10 kHz 10 Hz

ARI/RDS functions (directly selectable by menu or remote control)	
ARI identification	selection of traffic announcement identification (DK) or area identification (BK), OFF, DK, BK, DK + BK
ARI BK	selection of standardized area identification A to F
RDS traffic program	traffic program off/on
RDS traffic announcement	traffic announcement off/on
RDS data set Maximum data length	selection of RDS data set 1 to 5 64 kByte, can be loaded via IEC625 or RS-232-C interface
Analog modulation inputs L, R	2 x BNC
Input impedance	600 Ω or 100 kΩ
Input voltage V_p for selected deviation (nominal value)	1 V
Digital modulation input S/P DIF	BNC
Input impedance	75 Ω
Input voltage V_{pp}	1 V (400 mV to 5 V)

[1] Generator without preemphasis, receiver with deemphasis

Designation	**Type**	**Order No.**
Stereo/RDS Coder	R&S SML-B5	1147.8805.02
Signal Generator	R&S SML01	1090.3000.11
Signal Generator	R&S SML02	1090.3000.12
Signal Generator	R&S SML03	1090.3000.13
Vector Signal Generator	R&S SMV03	1147.7509.13

Signal Generator R&S SML	PD 0757.5550
Vector Signal Generator R&S SMV03	PD 0757.7175
Audio Analyzer R&S UPL	PD 0757.2238
Audio Switcher R&S UPZ	PD 0757.6985

Certified Environmental System ISO 14001 SREG. NR. 1954

Certified Quality System ISO 9001 SQS REG. NR. 1954

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0602 Printed in Germany

Typical values · Data without tole · Subject to change · Trade names are trademarks of the owners · 7152.21 · Stereo/RDS Coder R&S SML-B5

Safety Instructions

This unit has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards.

To maintain this condition and to ensure safe operation, the user must observe all instructions and warnings given in this operating manual.

Safety-related symbols used on equipment and documentation from R&S:

Observe operating instructions

Weight indication for units >18 kg

PE terminal

Ground terminal

Danger! Shock hazard

Warning! Hot surfaces

Ground

Attention! Electrostatic sensitive devices require special care

1. The unit may be used only in the operating conditions and positions specified by the manufacturer. Unless otherwise agreed, the following applies to R&S products:

   IP degree of protection 2X, pollution severity 2 overvoltage category 2, only for indoor use, altitude max. 2000 m.

   The unit may be operated only from supply networks fused with max. 16 A.

   Unless specified otherwise in the data sheet, a tolerance of ±10% shall apply to the nominal voltage and of ±5% to the nominal frequency.

2. For measurements in circuits with voltages V_{rms} > 30 V, suitable measures should be taken to avoid any hazards.

   (using, for example, appropriate measuring equipment, fusing, current limiting, electrical separation, insulation).

3. If the unit is to be permanently wired, the PE terminal of the unit must first be connected to the PE conductor on site before any other connections are made. Installation and cabling of the unit to be performed only by qualified technical personnel.

4. For permanently installed units without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused such as to provide suitable protection for the users and equipment.

5. Prior to switching on the unit, it must be ensured that the nominal voltage set on the unit matches the nominal voltage of the AC supply network.

   If a different voltage is to be set, the power fuse of the unit may have to be changed accordingly.

6. Units of protection class I with disconnectible AC supply cable and appliance connector may be operated only from a power socket with earthing contact and with the PE conductor connected.

7. It is not permissible to interrupt the PE conductor intentionally, neither in the incoming cable nor on the unit itself as this may cause the unit to become electrically hazardous.

   Any extension lines or multiple socket outlets used must be checked for compliance with relevant safety standards at regular intervals.

8. If the unit has no power switch for disconnection from the AC supply, the plug of the connecting cable is regarded as the disconnecting device. In such cases it must be ensured that the power plug is easily reachable and accessible at all times (length of connecting cable approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply.

   If units without power switches are integrated in racks or systems, a disconnecting device must be provided at system level.

9. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed.

   Prior to performing any work on the unit or opening the unit, the latter must be disconnected from the supply network.

   Any adjustments, replacements of parts, maintenance or repair may be carried out only by authorized R&S technical personnel.

   Only original parts may be used for replacing parts relevant to safety (eg power switches, power transformers, fuses). A safety test must be performed after each replacement of parts relevant to safety.

   (visual inspection, PE conductor test, insulation-resistance, leakage-current measurement, functional test).

continued overleaf

10. Ensure that the connections with information technology equipment comply with IEC950 / EN60950.
11. Lithium batteries must not be exposed to high temperatures or fire.

    Keep batteries away from children.

    If the battery is replaced improperly, there is danger of explosion. Only replace the battery by R&S type (see spare part list).

    Lithium batteries are suitable for environmentally-friendly disposal or specialized recycling. Dispose them into appropriate containers, only.

    Do not short-circuit the battery.
12. Equipment returned or sent in for repair must be packed in the original packing or in packing with electrostatic and mechanical protection.
13. Electrostatics via the connectors may damage the equipment. For the safe handling and operation of the equipment, appropriate measures against electrostatics should be implemented.
14. The outside of the instrument is suitably cleaned using a soft, lint-free dustcloth. Never use solvents such as thinners, acetone and similar things, as they may damage the front panel labeling or plastic parts.
15. Any additional safety instructions given in this manual are also to be observed.

ROHDE&SCHWARZ

EC Certificate of Conformity

CE

Certificate No.: 99059

This is to certify that:

Equipment type	Stock No.	Designation
SML01	1090.3000.11	Signal Generator 9 kHz ... 1,1 GHz
SML02	1090.3000.12	Signal Generator 9 kHz ... 2,2 GHz
SML03	1090.3000.13	Signal Generator 9 kHz ... 3,3 GHz
SML-B1	1090.5790.02	Option: Reference Oscillator OXCO
SML-B3	1090.5403.02	Option: Pulse Modulator

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (73/23/EEC revised by 93/68/EEC)
- relating to electromagnetic compatibility (89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN61010-1 : 1993 + A2 : 1995
EN50081-1 : 1992
EN50082-2 : 1995

Affixing the EC conformity mark as from 1999

ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München

Munich, 2000-10-16

Central Quality Management FS-QZ / Becker

Certified Quality System

ISO 9001

DQS REG. NO 1954-04

Sehr geehrter Kunde,

Sie haben sich für den Kauf eines Rohde & Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Qualitätsmanagementsystems entwickelt, gefertigt und geprüft. Das Rohde & Schwarz-Qualitätsmanagementsystem ist nach ISO 9001 zertifiziert.

Dear Customer,

You have decided to buy a Rohde & Schwarz product. You are thus assured of receiving a product that is manufactured using the most modern methods available. This product was developed, manufactured and tested in compliance with our quality management system standards.
The Rohde & Schwarz quality management system is certified according to ISO 9001.

Cher client,

Vous avez choisi d'acheter un produit Rohde & Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes de gestion qualité.
Le système de gestion qualité de Rohde & Schwarz a été homologué conformément à la norme ISO 9001.

ROHDE&SCHWARZ

Support Center

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e-mail: **CustomerSupport@rsd.rohde-schwarz.com**

Für technische Fragen zu diesem Rohde & Schwarz-Gerät steht Ihnen ab sofort unsere Hotline der Rohde & Schwarz Vertriebs-GmbH, Support Center, zur Verfügung.

Unser Team bespricht mit Ihnen Ihre Fragen und sucht Lösungen für Ihre Probleme.

Die Hotline ist Montag bis Freitag von 8.00 bis 17.00 Uhr besetzt.

Bei Anfragen außerhalb der Geschäftszeiten hinterlassen Sie bitte eine Nachricht oder senden Sie eine Notiz per Fax oder e-mail. Wir setzen uns dann baldmöglichst mit Ihnen in Verbindung.

Möchten Sie über Neuerungen und Updates zu einem bestimmten Gerät informiert werden, senden Sie bitte eine kurze e-mail unter Angabe des Gerätes. Sie erhalten dann regelmäßig die aktuellen Informationen zugesandt.

Should you have any technical questions concerning this Rohde & Schwarz product, please contact the hotline of Rohde & Schwarz Vertriebs-GmbH, Support Center.

Our hotline team will answer your questions and find solutions to your problems.

You can reach the hotline Monday through Friday from 8:00 until 17:00.

If you need assistance outside office hours, please leave a message or send us a fax or e-mail. We will contact you as soon as possible.

If you wish to receive the latest news about and updates for a specific instrument, please send us a short e-mail indicating the instrument. We will then send you up-to-date information on a regular basis.

ROHDE&SCHWARZ

1007.8684.14-01.00

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General Overview of Manuals

Operating Manual for Signal Generator SML

This operating manual provides you with all the information necessary for putting into operation, manual and remote control as well as maintaining of Signal Generator SML and also contains specifications of the instrument and available options.

The following models are described in this manual:

SML01	9 kHz to 1.1 GHz
SML02	9 kHz to 2.2 GHz
SML03	9 kHz to 3.3 GHz

The contents of the chapters are as follows:

Data sheet informs you about guaranteed specifications relating to functions and characteristics of the instrument and its options.

Chapter 1 contains all information about putting into operation (unpacking, connection to AC supply, switching on and off), functional testing and installation of the instrument, preset settings and views of the front and rear panel showing the controls and connectors needed for operation.

Chapter 2 presents a brief introduction and typical settings to users working with the SML for the first time.

Chapter 3 describes manual control of the signal generator, for example calling up of menus, selection and editing of parameters, use of the list editor and the SAVE/RECALL function. This chapter also contains an overview of menus showing the functions available for the instruments and its options.

Chapter 4 describes the functions of the instrument and its options which can be activated manually via menus or by remote control (frequency and level settings, analog modulations, sweep and general functions not directly related to signal generation).

Chapter 5 provides basic information on remote control, for example on the IEC/IEEE bus, RS-232-C interface, interface and device messages, command processing, status reporting system, etc.

Chapter 6 contains for each command system an overview and description of all commands available for the instrument and its options as well as an alphabetical list of all commands.

Chapter 7 includes programming examples for remote control.

Chapter 8 gives information on preventive maintenance, for example for keeping the exterior clean, storage, etc.

Chapter 9 contains the SCPI-specific and device-specific error messages displayed on the instrument.

Chapter 10 includes the performance test with the performance test report.

1 Putting into Operation

This chapter contains all information about putting into operation (unpacking, connection to AC supply, switching on and off), functional testing and installation of the instrument, preset settings and views of the front and rear panel showing the controls and connectors needed for operation.

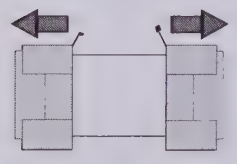
General Instructions

Before putting the SML into operation, please make sure that

- the cover of the casing are put on and screwed,
- the ventilation openings are free,
- no signal voltage levels exceeding the permissible limits are applied at the inputs,
- the outputs of the instrument are not overloaded or connected incorrectly.

If these points are not observed, the instrument might be damaged.

Unpacking the Instrument



remove protective cabs

➢ Take the instrument out of the shipping box and check whether the items listed in the packing list and in the lists of accessories are all included.

➢ Remove the two protective caps from the front and rear of the instrument and carefully check the instrument for damage.

Should the instrument be damaged, immediately notify the forwarder who shipped the instrument to you and keep the box and packing material.
For further transport or shipment of the instrument the original packing should also be used. It is recommended to keep at least the two protective caps for front and rear side in order to prevent damage to the controls and connectors.

Setting up the Instrument

For applications in the laboratory or on a work bench, it is recommended that the support feet on the bottom of the instrument be extended. For the LCD display, this provides the optimum viewing angle which typically ranges from perpendicular to the display front to approximately 30° below.

Warning

The feet must be fully folded in or out. Only in this way can the stability of SML be guaranteed and reliable operation be ensured. With the feet out, the weight of other units put onto SML must not exceed 30 kg. The units must be secured against slipping (eg by locking the feet of the unit at the top side of the enclosure).

When shifting the unit with the feet out, the feet might collapse and fold in. To avoid injuries, the unit must therefore not be shifted with the feet out.

Supply Voltage

The SML can be operated at a.c. systems from 100 to 120 V and 200 to 240 V at system frequencies from 50 to 60 Hz. The power supply socket is situated at the rear of the instrument. The instrument automatically sets itself to the voltage applied within the permissible voltage ranges. It is not necessary to set the instrument to a certain supply voltage.

How to Ensure EMC

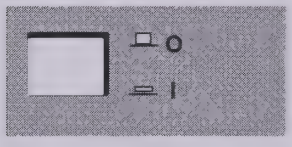
In order to avoid electromagnetic interference, the instrument may only be operated when it is closed and with all shielding covers fitted. Only appropriate shielded signal and control cables may be used.

Power Fuses

The SML is protected against short circuits by means of two fuses according to nameplate of the power supply. The fuses are situated in the draw-out fuse holder which is inserted close to the power supply socket (see below).

Power supply socket at the rear of the instrument

Switching On/Off the Instrument



Switch on: ➢ Press switch.
The instrument is ready for operation.

Switch off: ➢ Release switch.

On/Off switch at the front of the instrument

Initial Status

Upon switching on, the instrument automatically assumes the status which was set when it was switched off.
If the instrument need not to be operated from the initial status any further, a defined default status should be established by pressing the [PRESET] and [SELECT] keys prior to further settings.

Frequency accuracy after switching on when the oven-controlled reference oscillator is fitted (option SML-B1)

The reference oscillator needs some minutes of warm-up time to reach its nominal frequency. During this period of time, the output frequency does not yet reach its final value either. In the status line in the header field of the display the message "OVEN COLD" is displayed for this time.

RAM With Battery Back-Up

The SML has a static read-write memory (CMOS-RAM) with battery back-up, in which 50 different complete settings of the instrument can be stored (cf. Chapter 3, section "Storing and Calling of Instrument Settings"). In addition, all data and/or lists the user enters himself, such as for user correction of the level, are stored in the RAM. Further, all data of the calibrations running within the instrument in the SML are stored in the RAM (cf. Chapter 4, section "Calibration"). A lithium battery with a service life of approx. 5 years serves to supply the RAM with power. When the battery is discharged, the data stored will be lost. Exchanging the battery is described in the Service Manual.

Preset Setting

A defined setting status is achieved by pressing the [PRESET] key.

Preset Status:

RF frequency	100 MHz
RF level	-10 dBm
Reference frequency	internal, adjustment off
Offsets	0
Modulations	switched off
Transient-free level setting	switched off, level attenuator mode: Auto
Internal level control	level Alc: On
User correction	level Ucor: Off
LF output	switched off
Sweep	switched off
Suppression of indications	system security: unaltered
Protection of calibration data	protection lock: unaltered
Settings stored	unaltered
Data, lists etc. stored	unaltered
IEC-bus address	unaltered

All parameters and circuit states, even those of operating modes which are not activated, are preset by means of Preset. The presettings going beyond the above list can be seen from the menu representations as of Chapter 4 which each indicate the Preset setting status.

Functional Test

On switching on the instrument and permanently during operation, the SML carries out a self test. The ROM contents as well as the battery of the non-volatile RAM are checked. The most important instrument functions are automatically monitored during operation.
If an error is detected, the message "Err" is displayed in the status line. For further identification of the error, press the [ERROR] key. Thereupon a description of the error is displayed (cf. Chapter 9, section "Error Messages"). Return to the menu exited by pressing the [BACK] key.
If required, internal test points can be polled by the user and the results be read out and displayed, cf. Service Manual.

Mounting into a 19" Rack

Caution: *Ensure free air inlet at the perforation of the side walls and air outlet at the rear of the instrument in rack mounting.*

The SML can be mounted into a 19" rack by means of rack adapter ZZA-94 (stock no. 396.4905.00). The mounting instructions are attached to the adapter.

Explanation of Front and Rear Panel

Elements of the Front Panel

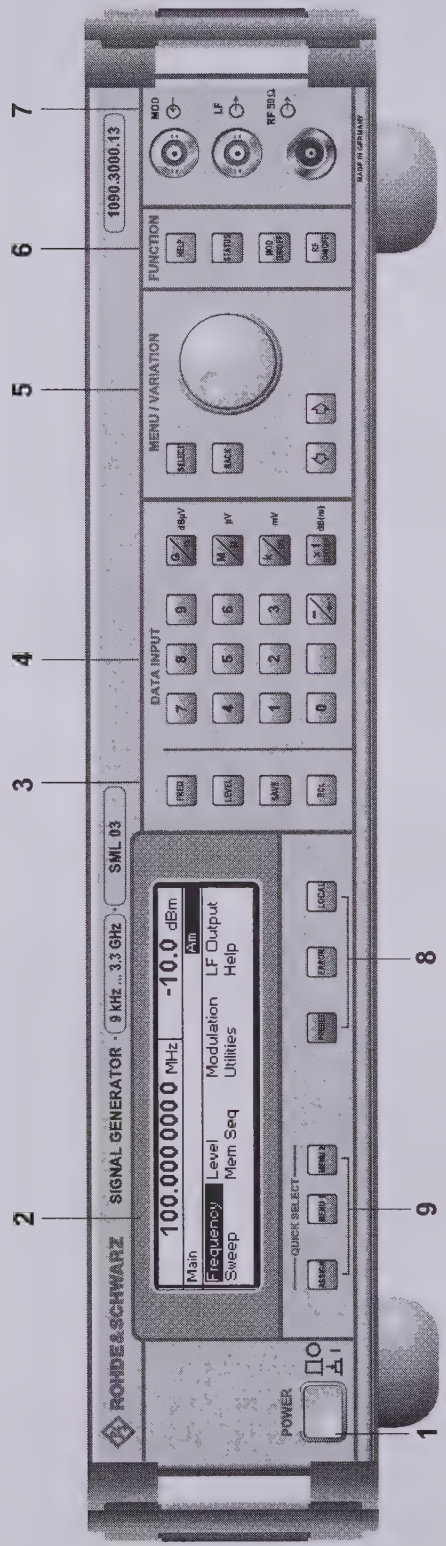
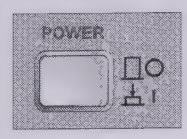


Fig. 1-1 Front panel view

1 ON/OFF SWITCH



The On/Off switch switches the instrument on ("I") or off ("O").

⇒ Cf. Chapter 1, Section "Switching On/Off the Instrument".

2 DISPLAY

Cf. Chapter 3 for the design of the display.

3

Parameter field

Parameters RF frequency and RF level can be entered directly by means of the parameter keys, alternatively to menu operation. Further, complete instrument settings can be stored and called.

FREQ Opens the setting of the RF frequency via value input or variation by means of a rotary knob. The current menu is maintained. Return to the menu by means of the [BACK] or [SELECT] key. (Setting of the RF frequency also in the FREQUENCY menu).

LEVEL Opens the setting of the RF level via value input or variation by means of a rotary knob. The current menu is maintained. Return to the menu by means of the [BACK] or [SELECT] key. (Setting of the RF level also in the LEVEL menu).

SAVE Opens the storing of the current instrument setting. Memory selection is effected by entering a number (1 to 50) and is finished by means of the [x1/ENTER] key.

RCL Opens the calling of an instrument setting stored. Memory selection is effected by entering a number (1 to 50) and is finished by means of the [x1/ENTER] key.

⇒ Cf. Chapter 3, Sections "Use of [FREQ] and [LEVEL] Keys", "RF Frequency", "RF Level" and "Storing and Calling of Instrument Settings".

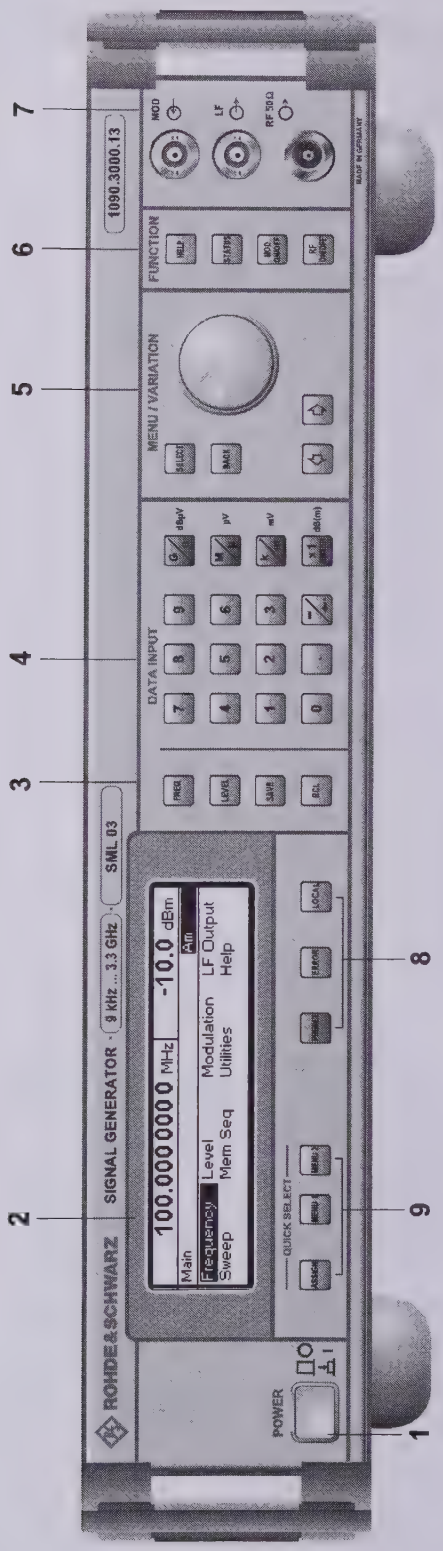
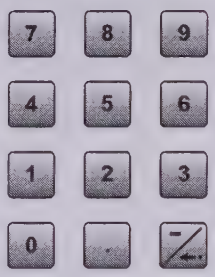


Fig. 1-1 Front panel view

4 DATA INPUT

Numeric input field



Numeric values, decimal point and minus sign can be entered by means of the digital keys.

0 to 9 Enters the digit.

• Enters the decimal point.

-/← Enters the minus sign.

Deletes the last input (digit, sign or decimal point) - key [BACKSPACE].

Unit keys with enter function

The unit keys terminate the input of values and specify the multiplication factor for the respective basic unit.

The basic units are displayed next to the input field while numbers are entered. In the case of level settings, the unit keys specify the unit.

G/n	dBµV	Selects giga/nano, with RF level dBµV.
M/µ	µV	Selects mega/micro, with level µV.
k/m	MV	Selects kilo/milli, with level mV.
X1 Enter	dB(m)	Terminates entries in the basic unit and value inputs without unit.
		Selects with level dBm.
		Selects with level offset and level step width dB.

In order to change to another level unit, simply press the unit key desired. Parameter LEVEL must be activated, e.g. by pressing the [LEVEL] key.

⇒ Cf. Chapter 3, Section "Change Unit of Level".

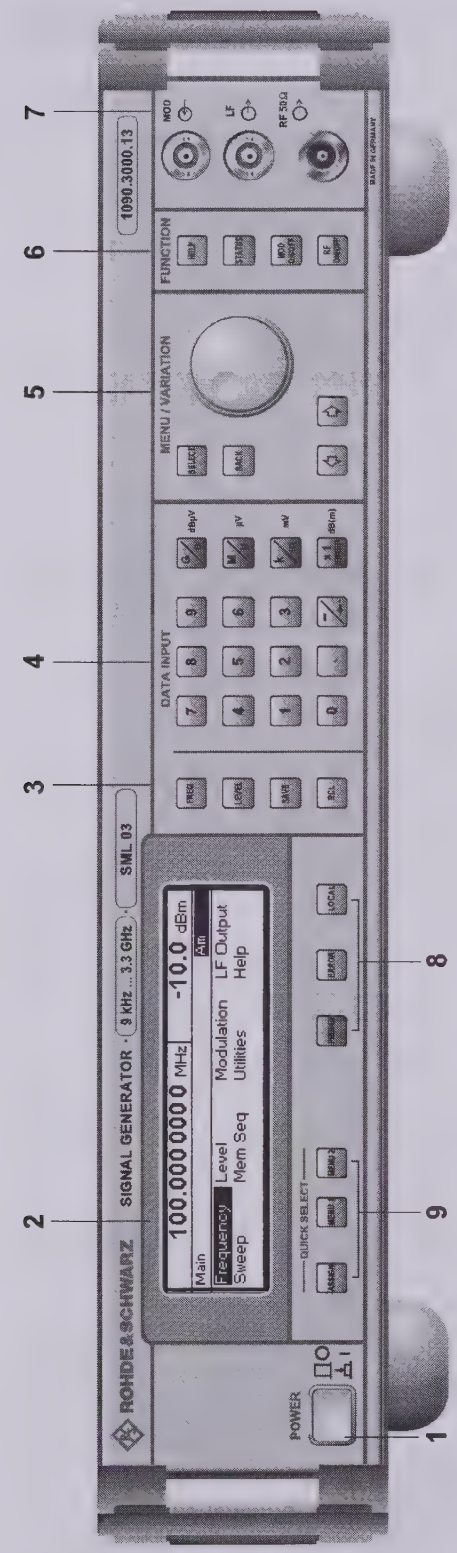


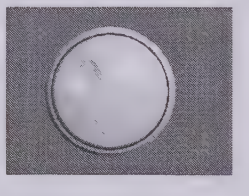
Fig. 1-1 Front panel view

5 MENU/VARIATION

Menu keys

The menu keys access the menus and settings within the menus.

SELECT	Acknowledges the choice marked by the menu cursor.
BACK	Returns the menu cursor to the next higher menu level.
⇐	Moves the digit cursor to the left by one position in the marked value indication.
	Moves the menu cursor to the top by one position in a 1-out-of-n selection.
⇒	Moves the digit cursor to the right by one position in the marked value indication.
	Moves the menu cursor to the bottom by one position in a 1-out-of-n selection.



Rotary knob

The rotary knob moves the menu cursor over the positions of a menu level to choose from, or varies the value of a parameter. The variation is either effected in steps of one or in a step width that can be specified at will.

Furthermore, by pressing the rotary knob when the cursor marks a menu position, the lower menu level or the setting menu is displayed (cf. function of [SELECT] key).

⇒ Cf. Chapter 2, Section "Sample Setting for First Users" and Chapter 3, Section "Basic Operating Steps".

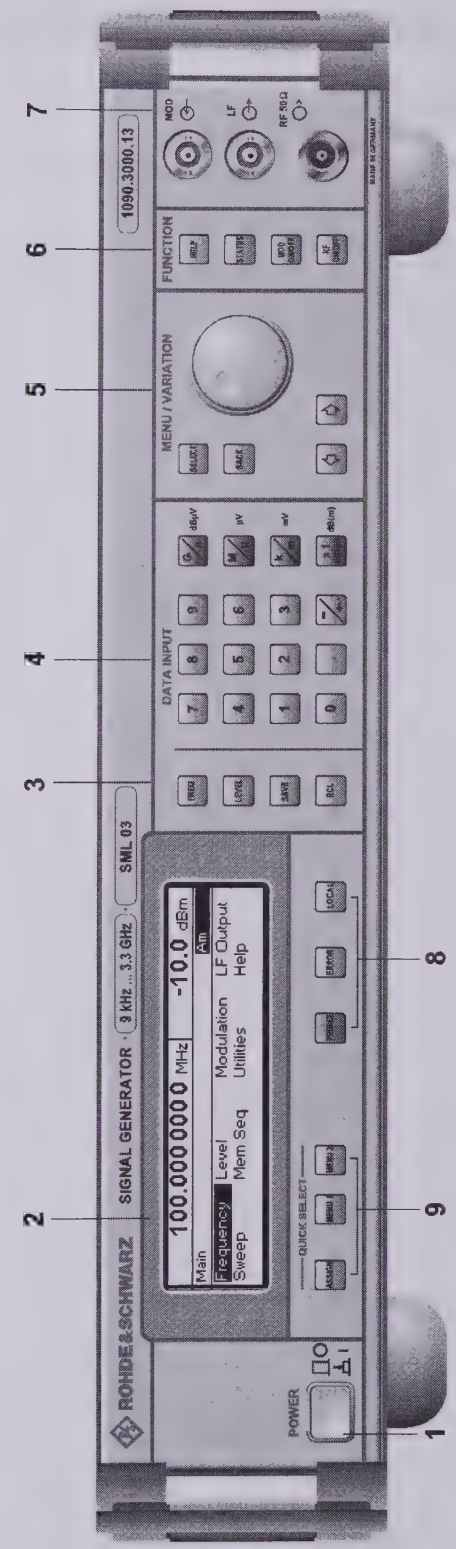


Fig. 1-1 Front panel view

6 FUNCTION

HELP*	Indicates context-sensitive auxiliary text.
STATUS*	Indicates the instrument status.
MOD ON/OFF	Switches on/off the modulation selected in Utilities - ModKey.
RF ON/OFF	Switches on/off the RF signal.

⇒ Cf. Chapter 4, Sections "The Help System", "Status", and Chapter 3, Section "Use of [MOD ON/OFF] and [RF ON/OFF] keys".

* Exit the menus using the [BACK] key.

7

MOD	Input of external modulation signal alternately for AM, FM and φM.
LF	Output LF signal of the internal LF generator.
RF 50 Ω	Output RF signal.

⇒ Cf. Chapter 4, Sections "LF Output" and "[RF ON/OFF] key".

8

PRESET	Establishes a defined instrument status. Confirm by [SELEC] key.
ERROR*	Indicates error and caution messages.
LOCAL	Switches the instrument from the REMOTE mode (remote control) to the LOCAL mode (manual control).

⇒ Cf. Chapter 1, Section "Preset Settings", Chapter 9, "Error Messages" and Chapter 6, "Remote Control".

* Exit the menus using the [BACK] key.

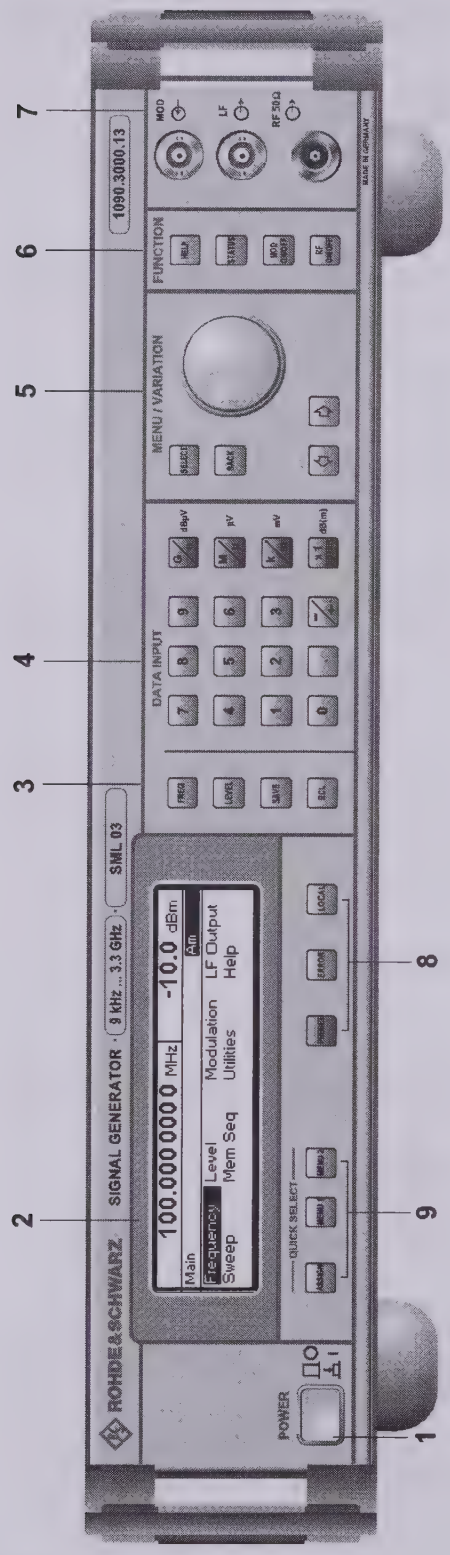


Fig. 1-1 Front panel view

9 QUICK SELECT

The menu-quick-selection keys permit fast access to two menus selected.

ASSIGN — Stores the current menu as menu1 when the MENU1 key is pressed afterwards or as menu2 when the MENU2 key is pressed afterwards.

MENU1 — Activates menu1 stored.

MENU2 — Activates menu2 stored.

⇒ Cf. Chapter 3, Section "Quick Selection of Menu (QUICK SELECT)".

Elements of the Rear Panel

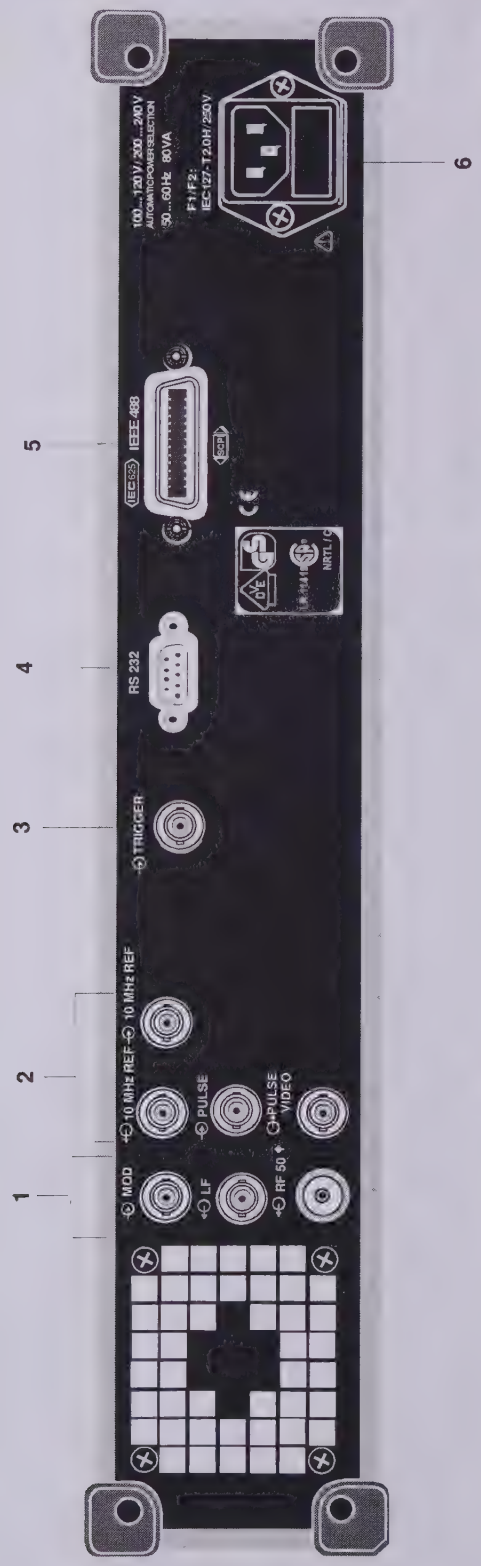


Fig. 1-2 Rear panel view

1

MOD Relocation of MOD input for external modulation signals. Only with option SML-B19.

LF Relocation of LF output for signals of internal LF generator. Only with option SML-B19.

RF 50 Ω Relocation of output for RF signals. Only with option SML-B19.

2

10 MHz REF Output of the internal 10-MHz-reference signal with reference internal.
Input for external reference frequency 10 MHz with reference external.

PULSE Input for triggering the pulse generator or for direct control of the pulse modulation. Only with option SML-B3.

PULSE/ VIDEO Output of pulse generator or video output (only with option SML-B3).

⇒ Cf. Chapter 4, Section "Pulse Generator".

3

TRIGGER Input to trigger the sweep.

⇒ Cf. Chapter 4, Sections "Sweep Inputs".

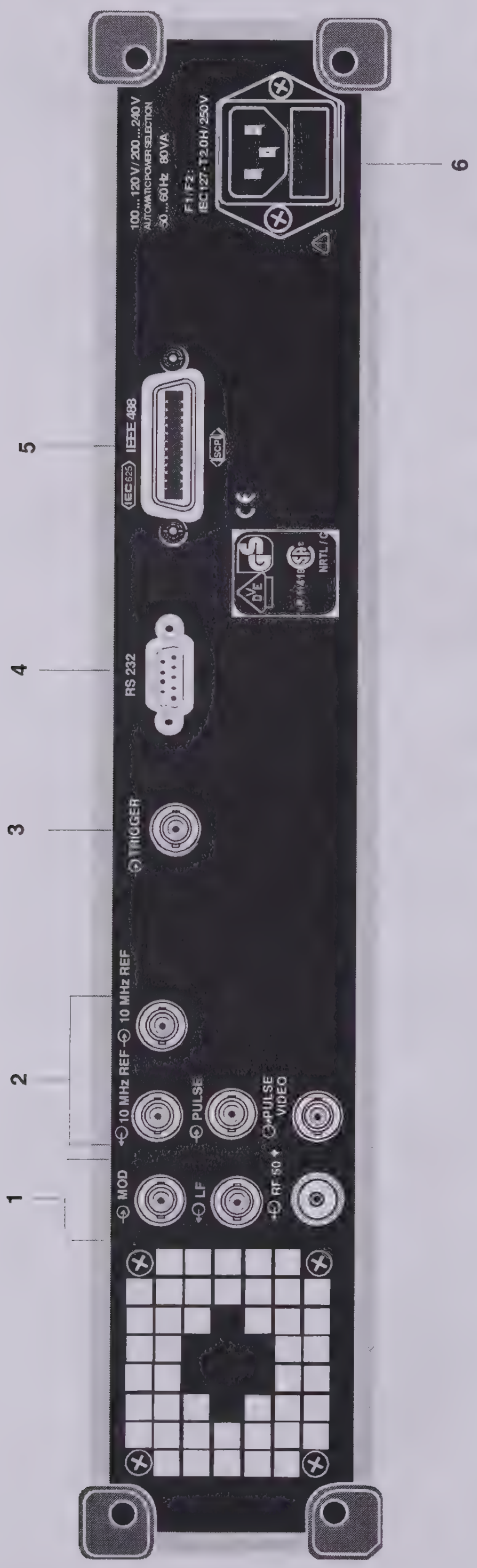


Fig. 1-2 Rear panel view

4

RS-232 RS-232-C interface
used for software update and remote control. The pin assignment corresponds to the pin assignment of a PC.

⇒ Cf. Chapter 5, Section "Interface RS-232-C".

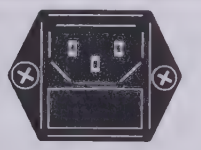
5

IEC 625 IEC-bus (IEEE 488)

IEEE 488 Interface for Remote Control

⇒ Cf. Chapter 5 "Remote Control".

6



Power supply connector and
fuse holder

⇒ Cf. Chapter 1, Section “Power Fuses”.

2 Short Tutorial

The present chapter contains a short tutorial with sample settings allowing the users to operate immediately the instrument.

Sample Setting for First Users

Setting frequency and level of the RF output signal

First frequency and level of the RF output signal are set via keys [FREQ] and [LEVEL] in the DATA INPUT field:

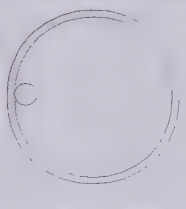
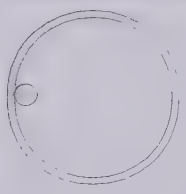
- Frequency 500 MHz
- Level 10 dBm

Operating steps	Explanations
MENU / VARIATION PRESET SELECT	Reset the instrument to the defined state.
DATA INPUT FREQ 5 0 0 M/µ dBµV	Set the frequency to 500 MHz. The menu cursor marks the permanent frequency indication.
DATA INPUT LEVEL 1 0 x1 ENTER dB(m)	Set the level to 10 dBm. The menu cursor marks the permanent level indication.
BACK	Reset the menu cursor to the menu field.

AM modulation of the output signal

The output signal is to be amplitude-modulated next.

- AM modulation depth 10.5 %
- AM signal 3-kHz sine

Operating steps	Explanations
MENU / VARIATION Modulation **MENU / VARIATION** SELECT	Select menu Modulation using rotary knob. Press [SELECT] key or rotary knob. The submenu is displayed.
MENU / VARIATION AM **MENU / VARIATION** SELECT	Select submenu AM. Press [SELECT] key or rotary knob. The AM setting menu is displayed.
MENU / VARIATION  AM Depth **MENU / VARIATION** SELECT	Select parameter AM Depth using rotary knob. Press [SELECT] key or rotary knob. The menu cursor marks the setting value.
DATA INPUT 1 0 . 5 x1 ENTER	Enter modulation depth 10.5 % and acknowledge using [x1/Enter] key.
BACK	Reset menu cursor to AM Depth using [BACK] key.
MENU / VARIATION  AM Source **MENU / VARIATION** SELECT	Select AM Source using rotary knob. Press [SELECT] key or rotary knob. A pop-up menu displays the current 1-out-of-n selection.

Operating steps	Explanations
MENU / VARIATION LFGen MENU / VARIATION SELECT	Select LF generator as modulation source using rotary knob. The selection mark marks LFGen.
BACK	Press [BACK] key. The cursor is set back to AM Source.
MENU / VARIATION LFGen Freq MENU / VARIATION SELECT	Select parameter LFGen Freq using rotary knob. Press [SELECT] key or rotary knob. The menu cursor marks the current frequency selection.
DATA INPUT 3 k/m mV	Set the frequency of the LF generator to 3 kHz. The AM modulation setting is completed. The indications on the display are represented in Fig. 2-1.

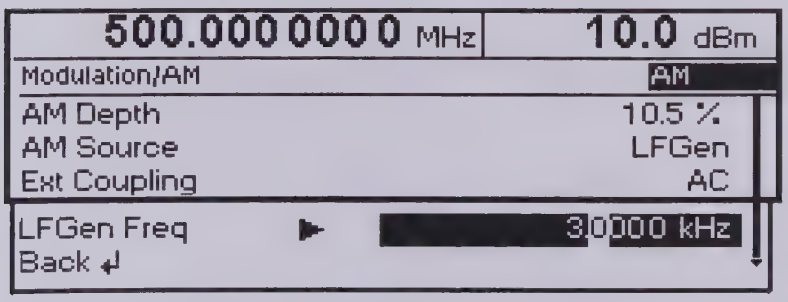
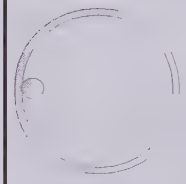
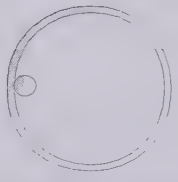


Fig. 2-1 Display for AM setting

Setting the step width

Subsequently to the above setting, 1 GHz as new RF frequency and 12 kHz as the step width for the RF frequency variation are set in the following.

Operating steps	Explanations
BACK BACK BACK	Reset the menu cursor to the main menu in 3 steps.
MENU / VARIATION Frequency MENU / VARIATION SELECT	Select menu Frequency using rotary knob. Press [SELECT] key or rotary knob. The frequency setting menu is displayed.
MENU / VARIATION  Frequency MENU / VARIATION SELECT	Select parameter Frequency. Press [SELECT] key or rotary knob. The menu cursor marks the setting value.
DATA INPUT 1 G/n dBµV	Enter frequency 1 GHz.
BACK	Press [BACK] key. The menu cursor is set back to Frequency.
MENU / VARIATION  Knob Step User MENU / VARIATION SELECT	Select parameter Knob Step User using rotary knob. Press [SELECT] key or rotary knob.
DATA INPUT 1 2 k/m mV	Enter step width 12 kHz.

Operating steps	Explanations
BACK	Press [BACK] key. The menu cursor is set back to Knob Step User.
MENU / VARIATION Knob Step MENU / VARIATION SELECT	Select parameter Knob Step using rotary knob. Press [SELECT] key or rotary knob. A pop-up menu displays the available settings.
MENU / VARIATION User MENU / VARIATION SELECT	Select User (user-defined step width) using rotary knob. This results in step width 12 kHz being used in the case of variation using the rotary knob.
BACK	Press [BACK] key. The menu cursor is set back to Knob Step.

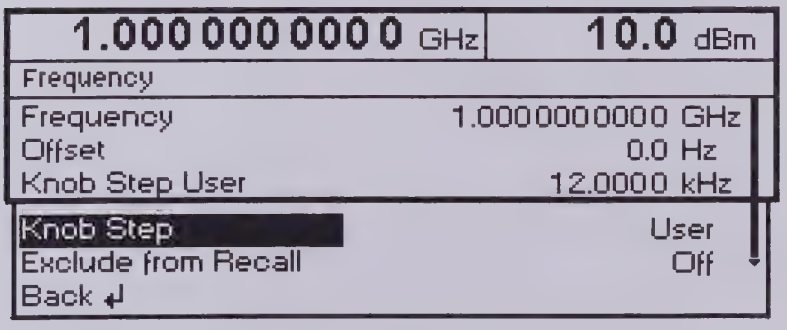


Fig. 2-2 Display for pattern setting

3 Manual Operation

This chapter shows the design of the display and describes the manual control of the signal generator, for example calling up of menus, selection and editing of parameters, use of the list editor and the SAVE/RECALL function. This chapter also contains an overview of menus showing the functions available for the instruments and its options.

It is useful to read the sample settings for first users in Chapter 2, "Short Tutorial".

Design of the Display

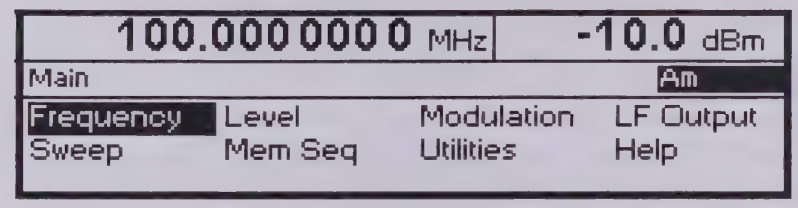


Fig. 3-1 Design of the display

(1) Header field The header field of the display indicates frequency and level of the RF output signal. In the RF-sweep operating mode, the start and stop frequencies are displayed in two lines one above the other. The start and stop levels are indicated in the LEVEL-sweep operating mode correspondingly.

(2) Status line The status line indicates at the left the menu path of the current menu and at the right the operating mode and operating state of the instrument. Error messages and notes for caution are also displayed in the status line.

(3) Menu fields The indication fields below the status line are reserved for the menu representations. The image contents of these fields change as a function of the menu selected.

The lowest menu level shows the setting menu with the current settings of the selected menu. Settings are made in select or input windows which open when the current setting is activated.

Menu cursor The menu cursor shows the user at which position in the menu he is. The position of the menu cursor is evident from the inverse notation of the term (white characters on a black background).

Digit cursor As a bright field, the digit cursor marks the position which can be varied by means of the rotary knob in a value indication.

Basic Operating Steps

To operate the instrument, menus are called in the display. All setting possibilities and the current setting status are evident from the menus. All settings can be made by accessing the menus.
RF frequency and RF level can also be set without menu operation using keys [FREQ] and [LEVEL]. RF signal and modulation can also be switched on/off without menu operation using keys [RF ON/OFF] and/or [MOD ON/OFF].

Calling the menus

Accessing the menus is effected using rotary knob [VARIATION], [SELECT] key and [BACK] key.

Rotary knob Rotary knob [VARIATION] moves the menu cursor over the positions of a menu level to be selected.
If a scrollbar is visible at the right-hand margin of a menu, the menu is larger than the screen window. If the menu cursor is moved to the margin of the screen window, the covered lines become visible.

If the rotary knob is pressed after a position has been selected, the lower menu level or the respective settings are called. The rotary knob hence has the same function as the [SELECT] key.

[SELECT] key The [SELECT] key acknowledges the selection marked by means of the menu cursor. Depending on the position, the next lower menu level or the the respective setting is called.

[BACK] key The [BACK] key

- returns the menu cursor to the next higher menu level; the menu cursor is shifted to the left into the preceding column of the menu structure,
- resets the menu cursor from frequency or level value indication in the header field into the menu field to the menu called last,
- closes the display pages called using keys [STATUS], [HELP] and [ERROR] again.

Settings are accessed in the setting menus ending with the right-hand display margin.

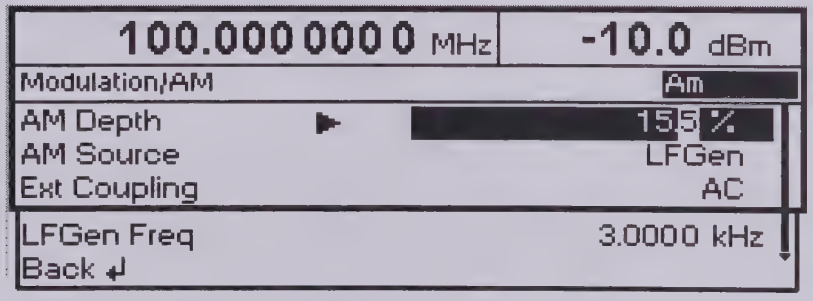


Fig. 3-2 Modulation - AM Menu

Selection and Change of Parameters

Select parameter

➢ Set the menu cursor to the name of the parameter desired using the rotary knob, e.g. to AM Depth in the AM menu, cf. Fig. 3-2.

Change setting value

➢ Select parameter.

➢ Press [SELECT] key or rotary knob.
The menu cursor changes from the parameter selected in the left-hand column of the setting menu to the setting value on the right, e.g. from AM Depth to 15%, cf. Fig. 3-2.

Via value inputs

➢ Press the first digit of the new value or minus sign.
The old value is deleted, the entry is indicated in the marked field.

➢ Enter further digits.

➢ Terminate the input using a unit key or, in the case of inputs in the base unit or in the case of inputs without unit, using the [1x/Enter] key.

➢ Press [BACK] key.

The menu cursor wraps back to the appropriate parameter.

Using rotary knob

➢ Set the digit cursor (bright field) to the position of the setting value to be varied using keys [⇦] [⇨].

➢ Turn rotary knob.
The value is varied.

Note: *RF frequency and RF level can also be varied in a step width which can be defined arbitrarily, using the rotary knob. In the respective setting menu (Frequency or Level), the step width is entered as Knob Step User and the Knob Step set from Decimal to User. To point to the fact that the step width has been converted to the value programmed, the bright field as a symbol of the digit cursor disappears in the respective value indication.*

1-out-of-n selection

- Select parameter.
- Press [SELECT] key or rotary knob.
  A pop-up menu displays a selection of settings.
- Set the menu cursor to the position desired within the 1-out-of-n selection using the rotary knob or cursor keys [⇐] [⇒].
- Press [SELECT] key or rotary knob.
  The setting is made.
  The pop-up menu is closed using [BACK] key and the current setting is indicated at the right margin of the display.
- Press [BACK] key or mark selection Back using rotary knob and then press rotary knob.

  The menu cursor wraps back to the next higher menu level.

Quick Selection of Menu (QUICK SELECT)

The keys of the QUICK SELECT control field are used to call selected menus quickly by one keystroke.

Store menus

- Establish the desired operating status of the current menu.
- Press [ASSIGN] key.
- Press [MENU1] or [MENU2] key.
  The current menu is stored as menu1 or menu2. That is to say, 2 menus can be stored in total.

Call menus

- Press [MENU1] or [MENU2] key.
  Menu1 or menu2 stored is displayed. Exactly the operating status which was current at the point of time of storing is reconstructed.

Use of [FREQ] and [LEVEL] Keys

RF frequency and RF level can be set without menu operation as well using direct keys [FREQ] and [LEVEL].

[FREQ] / [LEVEL] keys

➢ Press [FREQ] or [LEVEL] key.
The frequency or the level indication in the header field of the display is marked. The current menu at the display is maintained.

➢ Alter the value via a value input or the rotary knob.

➢ Press [BACK] or [SELECT] key.
The menu cursor wraps to the position marked last in the menu.

Use of [RF ON/OFF] and [MOD ON/OFF]

RF signal and modulation can be switched on/off without menu operation as well using keys [RF ON/OFF] or [MOD ON/OFF] (cf. Sections "[RF ON/OFF] Key" and "[MOD ON/OFF] Key").

[RF ON/OFF] key

➢ Press [RF ON/OFF] key.
The RF output signal is switched on/off.

IEC/IEEE-bus short command: `:OUTP:STAT ON`

[MOD ON/OFF] key

➢ Press [MOD ON/OFF] key.
Modulation is switched on/off.

A direct IEC-bus command is not available. The modulations have to be switched on and off in the respective modulation submenus.

Changing Unit of Level

For the level, the unit of the value set can be changed without a new value input.

Change level unit

➢ Activate Level parameter.

- Press [LEVEL] key or
- set menu cursor in the level menu to the setting value of the Amplitude parameter.

➢ Press the unit key with with the desired level unit.
The level is indicated in the desired unit.

Correction of Input

Digits can be corrected by one of the following keys before the input is confirmed by the [Enter] key:

Key [-/←] The backspace key deletes the value entered digit by digit.

[BACK] key Pressing the [BACK] key deletes the entire entry and results in the previous value being indicated again.

For a subsequent new input in the setting menu, the menu cursor is to be set to the setting value again using the [SELECT] key.

For a subsequent new input via the [FREQ] or [LEVEL] keys, the respective key has to be pressed again.

[FREQ]/[LEVEL] keys In the case of a frequency or level input by means of the [FREQ] or [LEVEL] keys, pressing the [FREQ] and/or [LEVEL] key again deletes the entire input.

List Editor

The SML offers the facility of generating lists for user-defined level correction (Ucor). The lists consist of elements (pairs of values) which are defined by an index and at least one parameter per index. Each list is assigned a separate name and selected by means of this name. Access to the lists is made in the associated menus. How to generate and edit lists is explained in detail in this section by the example of the user defined level correction Ucor (Level - UCor menu, see Fig. 3-3).

Menu selection: Level - UCor

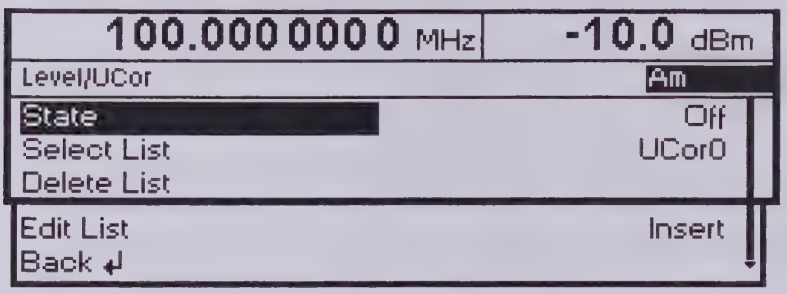


Fig. 3-3 Level - UCor menu

The settings for State are not relevant for the general description of the list editor. They are described in greater detail in chapter 4 in section "User Correction Ucor".

The Select List, Delete List and Edit List lines are always displayed. They are intended for the selection and deletion of lists and for the calling of editing functions.

Select List Opens a window in which a list out of 10 lists can be selected. In this line, the currently active list is displayed (see section "Select List").

Delete List Opens a window from which a list can be selected whose contents are to be deleted (see section "Delete List").

Edit List Selection of editing functions for list editing. When this item is selected, a pop-up menu with the following editing functions opens (see section "Edit List"):

- **Insert** Insertion of elements into a list
- **Fill** Filling of a list with elements
- **Edit/View** Editing of individual elements of a list
- **Delete** Deletion of elements of a list

If the list is empty, only selection Insert is available.

Select List

➢ Mark the desired list using the rotary knob (see Fig. 3-4).

➢ Press the [SELECT] key or the rotary knob.

The selected list is included in the instrument setup. The selection window is closed. The selected list is displayed under Select List.

Selection: Select List

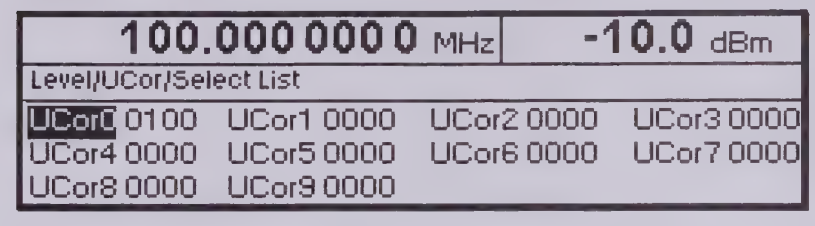

100.000 000 0 MHz
-10.0 dBm
Level/UCor/Select List
UCor0 0100 UCor1 0000 UCor2 0000 UCor3 0000
UCor4 0000 UCor5 0000 UCor6 0000 UCor7 0000
UCor8 0000 UCor9 0000

Fig. 3-4 Select List window

UCor0 The currently selected list, in this case Ucor0, is marked in the selection window.

0100 The length of the list, in this case 100 elements, is indicated in the column right of the list designation.

Delete List

➢ Mark the desired list using the rotary knob (see Fig. 3-5).

➢ Press the [SELECT] key or the rotary knob.
The following query will appear:
"Are you sure? Press SELECT to confirm BACK to cancel".

➢ Press the [SELECT] key or the rotary knob.
The contents of the list will be deleted. If the query is answered by pressing the [BACK] key, the contents of the list will be retained. The selection window is automatically closed upon answering the query.

Selection: Delete List

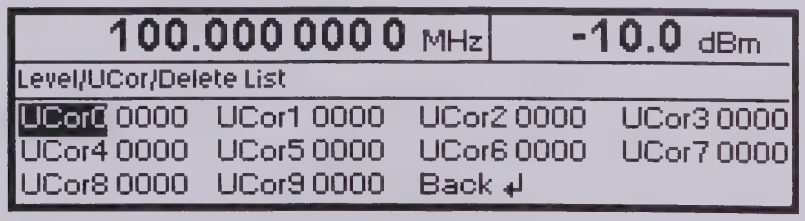

100.000 000 0 MHz
-10.0 dBm
Level/UCor/Delete List
UCor0 0000 UCor1 0000 UCor2 0000 UCor3 0000
UCor4 0000 UCor5 0000 UCor6 0000 UCor7 0000
UCor8 0000 UCor9 0000 Back

Fig. 3-5 Delete List window

Edit List

When Edit List is selected, a pop-up menu with the editing functions opens.

Insert editing function (see Fig. 3-6)

The Insert function inserts a desired number of elements with constant or linearly increasing/decreasing values ahead of the element with the indicated start index. All elements already existing from the start index are shifted so that they come at the end of the range of elements to be inserted.

Elements are inserted in a list according to the following procedure:

When Insert has been selected, the menu cursor is on the Insert At menu item.

- Press the [SELECT] key or the rotary knob.
  The menu cursor is on the value for At.
- Vary the index value by means of the rotary knob or enter an index value using the numerical keys and the [ENTER] key.
- Press the [SELECT] key or the rotary knob.
  The menu cursor is on the value for Range.
- Vary the Range value by means of the rotary knob or enter a value using the numerical keys and the [ENTER] key.
- Press the [SELECT] key or the rotary knob.
  The menu cursor is on the value for Start Frequency.
- Vary the start value for the frequency by means of the rotary knob or enter a value using the numerical keys and the [ENTER] key.
- Press the [SELECT] key or the rotary knob.
  The menu cursor is on the value for Increment Frequency.
- Vary the value of the increment by means of the rotary knob or enter a value using the numerical keys and the [ENTER] key.
- Press the [SELECT] key or the rotary knob.
  The menu cursor is on the value for Power.
- Vary the start value for the power by means of the rotary knob or enter a value using the numerical keys and the [ENTER] key.
- Press the [SELECT] key or the rotary knob.
  The menu cursor is on the value for Increment Power.
- Vary the value of the increment by means of the rotary knob or enter a value using the numerical keys and the [ENTER] key.
- The cursor is on Execute. Press the [SELECT] key or the rotary knob to execute the insertion. The menu cursor goes back to Edit List.

Upon pressing the [BACK] key, the editing window is exited without any change being made. The menu cursor goes back to Edit List.

Selection: Insert

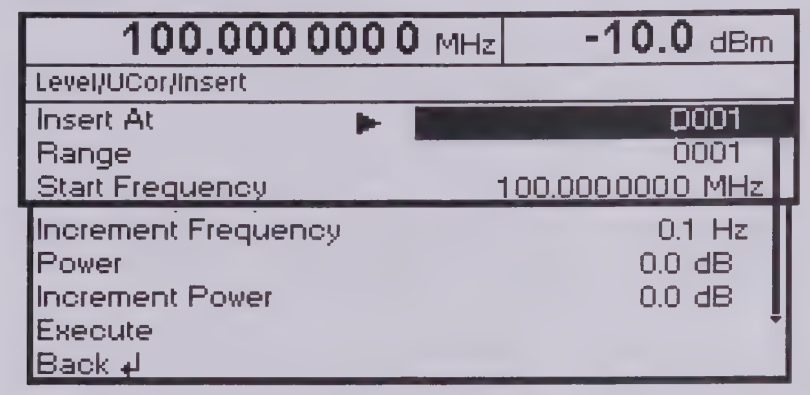


Fig. 3-6 Edit function Insert

Insert At Input of start index.

Range Number of elements to be inserted.

Start Frequency Input of start value for the frequency.

Increment Frequency Input of increment between two successive frequency values. If 0 is entered as an increment, identical values will be inserted.

Power Input of start value for the power.

Increment Power Input of increment between two successive power values. If 0 is entered as an increment, identical values will be inserted.

Execute Starts the insertion. After the execution of the function, the menu cursor goes back to Edit List.

Fill editing function (see Fig. 3-7)

The Fill function overwrites a parameter with constant or linearly increasing/decreasing values within a defined range. If the [BACK] key is pressed, the editing window will be exited without any change being made.
If the fill range extends beyond the end of the list, the list is automatically extended.

Filling of a list is done in the same way as the insertion of elements in a list, see "Insert editing function".

Selection: Fill

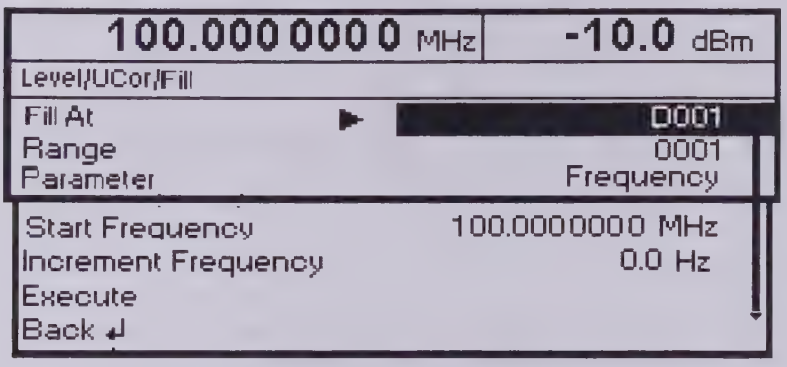


Fig. 3-7 Fill editing function

Fill At Input of start index.

Range Number of elements to be included.

Parameter Selection of parameters (frequency, power) to be filled. This menu option is not offered if a list contains only elements with one parameter.

Start Frequency Input of start value for the selected parameter. This option is offered only if Frequency is selected as a parameter.

Increment Frequency Input of increment between two successive values. If 0 is entered as an increment, the list will be filled with identical values. This option is offered only if Frequency is selected as a parameter.

Power Input of start value for the selected parameter. This option is offered only if Power is selected as a parameter.

Increment Power Input of increment between two successive values. If 0 is entered as an increment, the list will be filled with identical values. This option is offered only if Power is selected as a parameter.

Execute Starts the filling procedure. After the execution of the function, the menu cursor goes back to Edit List.

Edit/View editing function (see Fig. 3-8)

The Edit/View function allows viewing of a complete list or editing individual values of a list.

If the cursor is on a value in the left column of the list, the Edit/View mode can be exited by pressing the [BACK] key. The menu cursor goes back to Edit List.

There is no storage function for the list. This means that any modification of the list will be transferred to the internal data set and will be effective on exiting the Edit/View function.

Selection: Edit

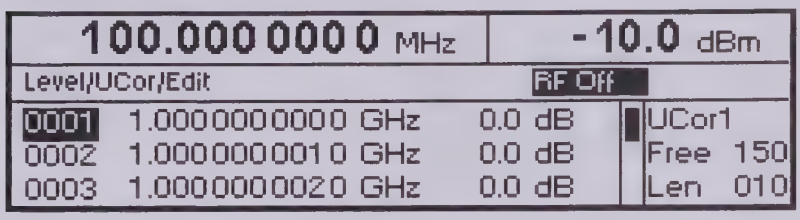


Fig. 3-8 Edit editing function

UCor Indication of list number

Free Available space. Free 150, for example, means that there is free space for a total of 150 pairs of values (elements) in the list memory.

Len Occupied space. Len 010, for example, means that the current list occupies 10 elements in the list memory.

Selection of index

- ➢ Select an index by means of the rotary knob or enter an index value by means of the numerical keys.

Editing of parameters

- ➢ Select the parameter (frequency, power) to be edited by means of the [SELECT] key.
- ➢ Vary the numerical value by means of the rotary knob or enter a numerical value using the numerical keys.
- ➢ Upon pressing the [BACK] key, the menu cursor goes back to the column left of the current column or to the Edit List menu.

Delete editing function (see Fig. 3-9)

The Delete function deletes the elements of the indicated range. After a delete no gap is left in the list but the remaining elements move up. If the indicated range extends beyond the end of the list, the elements until the end of the list are deleted.

The inputs for deleting elements from a list are the same as for inserting elements into a list, see section "Insert editing function".

Upon pressing the [BACK] key, the editing window will be exited without any change being made. The menu cursor goes back to Edit List.

Selection: Delete

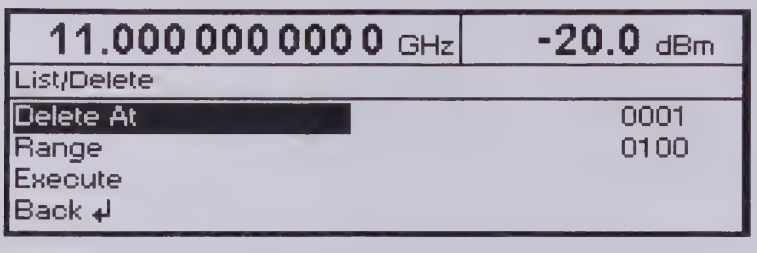


Fig. 3-9 Delete editing function

Delete At Input of first element to be deleted in a list

Range Number of elements to be deleted

Execute Starts the deletion. After the execution of the function, the menu cursor goes back to Edit List.

Storing/Calling of Instrument Settings (SAVE / RECALL)

50 complete instrument settings can be stored in memory locations 1 to 50.

Operating Steps	Explanations
DATA INPUT SAVE 1 2 x1 ENTER dB(m)	Store current instrument setting in memory location 12.
DATA INPUT RCL 1 2 x1 ENTER dB(m)	Call instrument setting of memory location 12.

The digital display during a save or recall entry is faded in a window.

If an instrument setting is stored in which a sweep was switched on, the sweep is started using the recall.

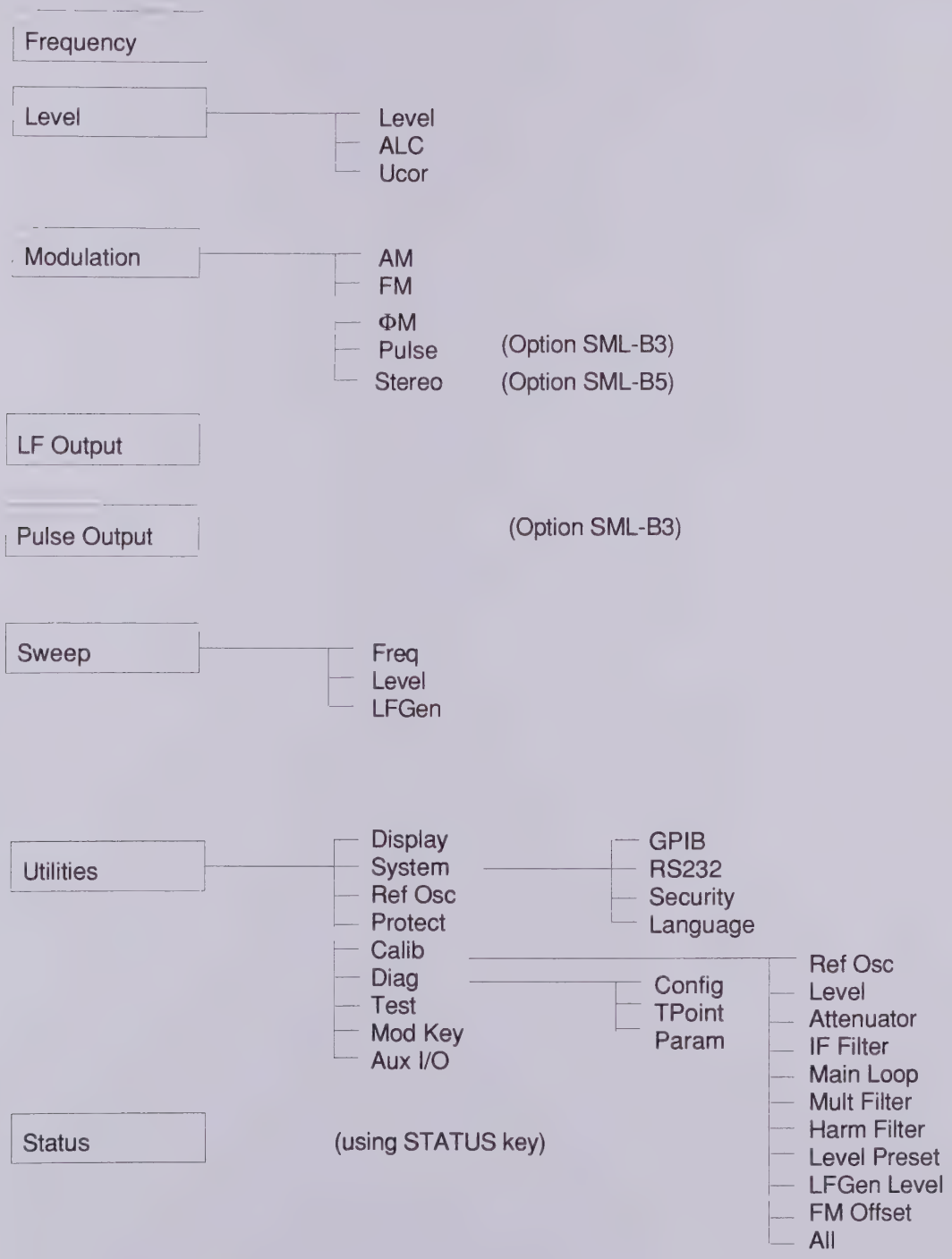
The parameter Exclude From Recall in the Frequency and Level-Level menus determines whether the saved RF frequency and RF level are loaded when an instrument setting is loaded, or whether the current settings are maintained.

Store IEC-bus command: `"*SAV 12"`

Call IEC-bus command: `"*RCL 12"`

Note: *The contents of lists, as they are used for user correction (Ucor), is not saved in the SAVE memory. It is stored under the respective list name and can be called. If instrument settings are called which go back to list data such as level setting using Ucor, the current list contents is used. If this has been altered, it is not identical to the list contents at the point of storing any more.*

Menu Summary



4 Instrument Functions

This chapter describes the functions of the instrument and its options which can be activated manually via menus or by remote control (frequency and level settings, analog modulations, sweep, and general functions not directly related to signal generation).

RF Frequency

The RF frequency can be set directly using the [FREQ] key or via the Frequency menu. In the Frequency menu, the frequency of the RF output signal is entered and indicated under Frequency.

In frequency settings made with the [FREQ] key, an arithmetic offset is taken into account. Such settings are indicated in the header line of the display. This makes it possible to enter the desired output frequency of subsequent units, if any (eg mixers). The offset can also be entered in the Frequency menu (see next section: "Frequency Offset").

Note:	*Further settings:*	*Frequency sweep*	*Sweep menu*
		LF frequency	*Modulation menu*
			LFOutput menu
		Int./ext. reference frequency	*Utilities - Ref Osc menu*

Menu selection: Frequency

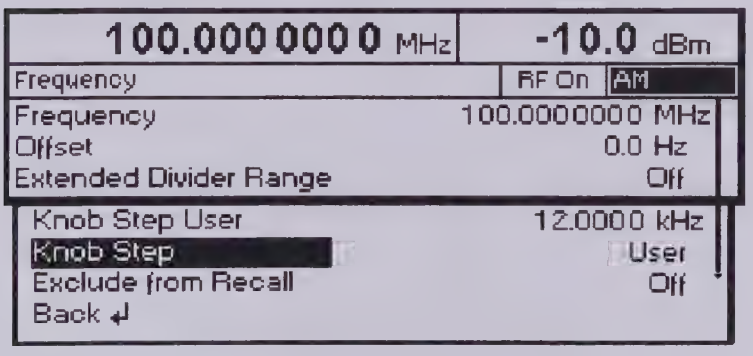


Fig. 4-1 Frequency menu

Frequency Input value of RF frequency at RF output connector.
IEC/IEEE-bus command `:SOUR:FREQ 100E6`

Offset Input value of frequency offset, for example of subsequent mixer.
IEC/IEEE-bus command `:SOUR:FREQ:OFFS 0`

Extended Divider Range

Off — Normal operation. The extended divider range is deactivated.
IEC-Bus-Befehl `:SOUR:FREQ:ERAN OFF`

On — The extended divider range is activated.
IEC/IEEE-bus command `:SOUR:FREQ:ERAN ON`

Knob Step User Input value of step size of frequency variation via rotary knob. The RF frequency is varied by the entered step size if Knob Step is set to User.

IEC/IEEE-bus command `:SOUR:FREQ:STEP 1MHz`

Knob Step

Decimal The variation step size corresponds to the position of the digit cursor.

User User-defined, the variation step size is as entered under Knob Step User.

Exclude from Recall

Off Normal setting. The stored frequency is loaded too when instrument settings are loaded with the [RCL] key.

IEC/IEEE-bus command `:SOUR:FREQ:RCL INCL`

On The stored frequency is not loaded when instrument settings are loaded, ie the current frequency setting is maintained.

IEC/IEEE-bus command `:SOUR:FREQ:RCL EXCL`

Frequency Offset

On the SML it is possible to enter an offset for subsequent units, if any, in the Frequency menu. Such entries are taken into account in the frequency displayed in the header line, which indicates the frequency of the RF signal at the output of the units in question (see Fig. 4-2).

The frequency of the RF output signal in the Frequency menu is calculated from the frequency displayed in the header line and offset values as follows:

RF output frequency = frequency displayed in header line – offset

The entry of an offset causes a change of the frequency value displayed in the header line (the value taking into account the offset is displayed). The value of the RF output frequency is displayed under Frequency in the Frequency menu.

The entered offset remains active also for frequency sweeps.

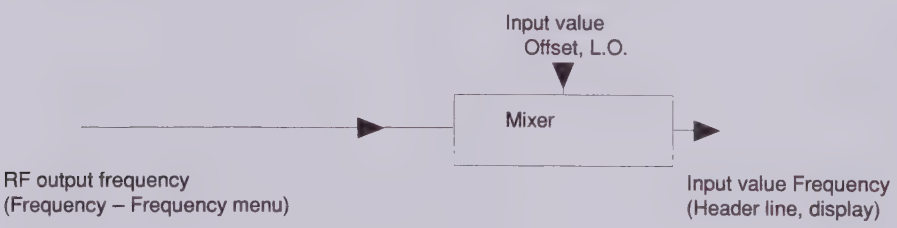


Fig. 4-2 Typical setups with frequency offset

Extended Divider Range

For frequencies of equal or greater than 77 MHz, the SML generates the RF signals by means of frequency division or frequency multiplication. Below 77 MHZ the RF signals are normally generated by frequency mixing. This results in good modulation capabilities but reduced single-side phase noise. (see fig. "Typical SSB phase noise versus carrier frequency" in the datasheet). When the extended divider range is activated excellent single-sideband phase noise values will be obtained in the frequency range from approximately 9.5 MHz to 77 MHz but all other specifications of the SML cannot be guaranteed for this operation mode.

RF Level

The RF level can be set directly using the [LEVEL] key or via the Level - Level menu.

In the Level - Level menu, the set RF output level is entered and indicated under Amplitude.

In level settings made with the [LEVEL] key, the offset of a subsequent attenuator/amplifier is taken into account (see section "Level Offset"). This makes it possible to enter the desired level at the output of subsequent units. The offset can also be entered in the Level - Level menu under Offset.

dBm, dBµV, mV and µV can be used as level units. The four unit keys are labelled with the respective units. To change to another level unit, simply press the corresponding unit key.

Note: - *The note "Unleveled" appears in the status line if the displayed level is not attained.*

- *Further settings: Level Sweep Sweep menu*

Menu selection: Level - Level

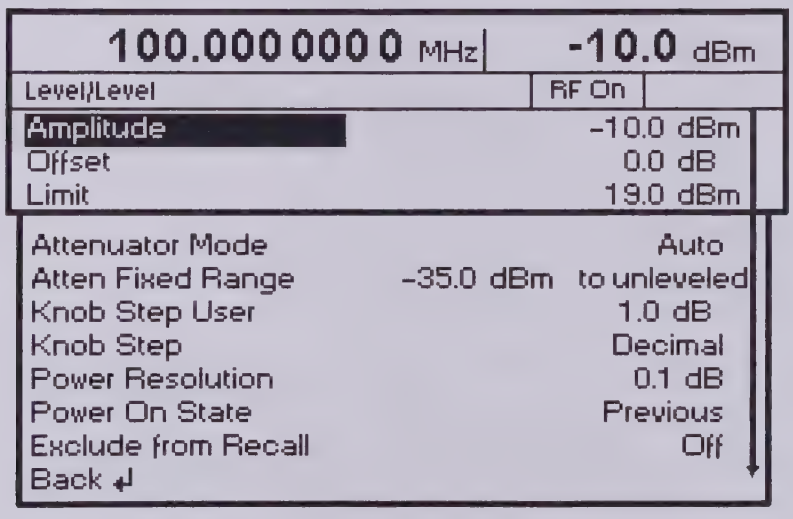


Fig. 4-3 Level menu

Amplitude Input value of RF level at RF output connector.
IEC/IEEE-bus command `:SOUR:POW -10`

Offset Input value of level offset of a subsequent attenuator/amplifier. Input value in dB (see section "Level Offset").
IEC/IEEE-bus command `:SOUR:POW:OFFS 0`

Limit

Input value of level limit. This value indicates the upper limit of the level at the RF output connector. A warning is output in the status line if an attempt is made to set a level above this limit.

IEC/IEEE-bus command `:SOUR:POW:LIM 19 dBm`

Attenuator Mode

Auto — Normal setting. The electronically switched attenuator switches in steps of 5 dB at fixed points.

IEC/IEEE-bus command `:OUTP:AMOD AUTO`

Fixed — Level settings are made without switching the attenuator (see section "Non-Interrupting Level Setting").

IEC/IEEE-bus command `:OUTP:AMOD FIX`

Atten Fixed Range

Indicates the level range of non-interrupting level setting in "Attenuator Mode Fixed".

Knob Step User

Input value of step size of level variation via rotary knob. The RF level is varied by the entered step size if Knob Step is set to User.

IEC/IEEE-bus command `:SOUR:POW:STEP 1`

Knob Step

Decimal — The variation step size corresponds to the position of the digit cursor.

User — User-defined, the variation step size is as entered under Knob Step User (only in dB).

Power Resolution

Selection of resolution of level display

0.1 dB — The resolution of the level display is 0.1 dB.

0.01 dB — The resolution of the level display is 0.01 dB.

Power On State

Selection of status to be assumed by RF output after power-up of the instrument.

RF Off — The RF output is switched off.

Previous Setting — The RF output assumes the status active before switch-off.

IEC/IEEE-bus command `:OUTP:PON OFF`

Exclude from Recall

Off — Normal setting. The stored RF level is loaded too when instrument settings are loaded with the [RCL] key.

IEC/IEEE-bus command `:SOUR:POW:RCL INCL`

On — The stored RF level is not loaded when instrument settings are loaded, ie the current level setting is maintained.

IEC/IEEE-bus command `:SOUR:POW:RCL EXCL`

Level Offset

On the SML, it is possible to enter an offset for a subsequent attenuator/amplifier, if any, in the Level menu. The offset is taken into account in the display in the header line (see below), which represents the level value of the signal at the output of the subsequent unit (see Fig. 4-4).

The level of the RF output signal is therefore calculated from the amplitude displayed in the header line and the offset entered in the Level - Level menu as follows:

RF output level = amplitude displayed in the header line – offset

The entered offset has no influence on the RF output signal of the SML; the offset is only taken into account in the displayed level value. The value with the offset can be directly entered with the [LEVEL] key.

The RF output level of the SML is indicated in the Level - Level menu.

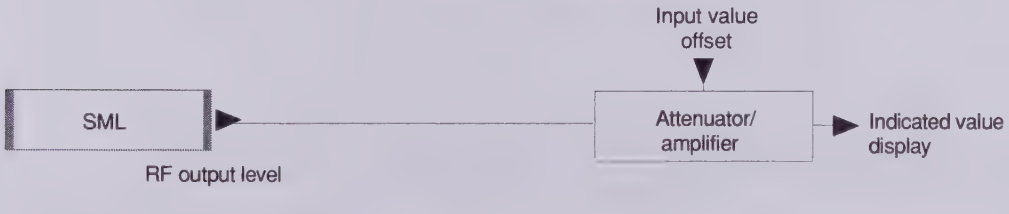


Fig. 4-4 Typical setup with level offset

Non-Interrupting Level Setting

With Attenuator Mode Fixed, non-interrupting level setting is performed. Electronic attenuator switching is used instead of interrupting, electronical attenuator switching.

If the level falls below the permissible variation range, the warning "Level underrange" is output in the status line of the display; if it attains or goes beyond the upper limit value, the warning "Level overrange" or “Unleveled” is output. Level accuracy and spectral purity are not guaranteed.

Switching On/Off Automatic Level Control (ALC)

Settings for automatic level control (ALC) can be made in the Level – ALC menu.

When level control is switched off (ALC State Off), switchover is made to a sample-and-hold mode or to a table mode. In the sample-and-hold mode, level control is switched on automatically for a short time after each level or frequency setting and the level control is held at the value attained. In the table mode, the correction values required after a frequency or level change are obtained from a table. With the Learn table function called up, a new table can be prepared. Level control OFF is used in multisource measurements to improve intermodulation suppression.

For vector modulation the level controll has to be switched off. If vector modultion is switched on the level control will be switched off automatically. The same is true for vectror modulation if the level control will be witched on.

In general level control OFF is used in multisource measurements to improve intermodulation suppression.

Menu selection: Level – ALC

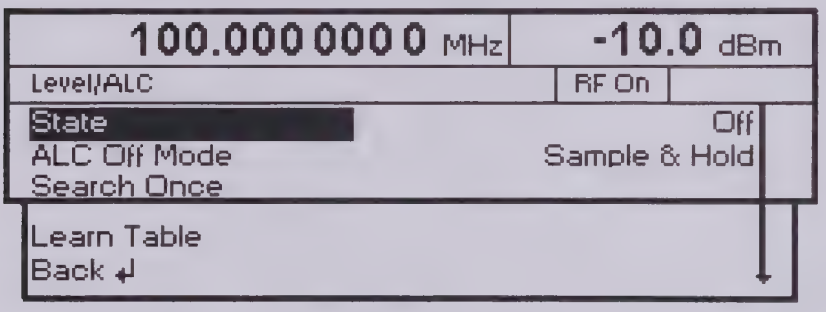


Fig. 4-5 Level - ALC menu (preset setting)

State

On Level control is switched on permanently. No vector modulation is possible in this status.

IEC-Bus-Befehl `:SOUR:POW:ALC OFF`

Off Level control is switched off. No AM is possible in this status.

IEC/IEEE-bus command `:SOUR:POW:ALC OFF`

ALC Off Mode

Sample & Hold Level recalibration after the level or frequency has been set.

IEC/IEEE-bus command `:SOUR:POW:ALC:SEAR ONCE ON`

Table In the ALC Off mode correction values are taken from a table.

IEC/IEEE-bus command `:SOUR:POW:ALC:SEAR ONCE OFF`

Learn Table

Correction values for the Table mode are regenerated.

IEC/IEEE-bus command `:SOUR:POW:ALC:TABL?`

User Correction (Ucor)

The "User correction" function can be used to create and activate lists in which level correction values are assigned to arbitrary RF frequencies.

Up to 10 lists with a total of 160 correction values can be compiled. For frequencies not included in the list, level correction values are determined by interpolation based on the nearest correction values.

When user correction is switched on, Ucor (user correction) is displayed in the header field in addition to the level. The RF output level is the sum of both values.

Level + Ucor = output level

If an offset is selected at the same time, the displayed level value is the difference between the amplitude and the offset entered in the Level menu.

Amplitude – offset = level

User correction is active in all operating modes when switched on.

Menu selection: Level - UCor

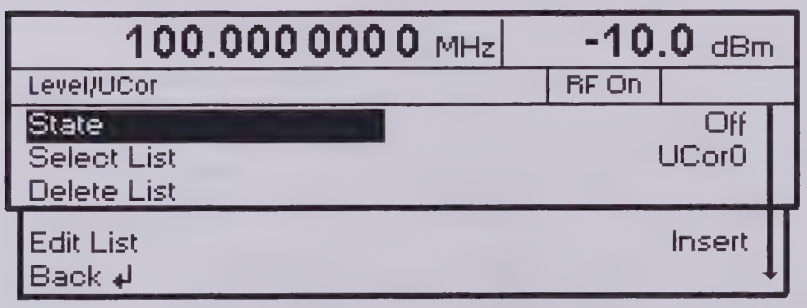


Fig. 4-6 Level - UCor menu

State Switching on/off user correction
IEC/IEEE-bus command `:SOUR:CORR ON`

Select List Selection of a list or generation of a new list
(see Chapter 3, Section "List Editor")
IEC/IEEE-bus command `:SOUR:CORR:CSET "UCOR1"`

Delete List Deletion of a list (see Chapter 3, Section "List Editor")
IEC/IEEE-bus command `:SOUR:CORR:CSET:DEL "UCOR2"`

Edit List Selection of editing mode for modifying a selected list
(see Chapter 3, Section "List Editor")
IEC/IEEE-bus commands

```
:SOUR:CORR:CSET:DATA:FREQ  105MHz,  107MHz,...
:SOUR:CORR:CSET:DATA:POW 1dB, 0.9dB, 0.8dB,...
```

Menu selection: Level - UCor

Fig. 4-7 UCor - Level menu

UCor Indication of list item number.

Free Available space. Free 150, for example, means that there is free space for a total of 150 pairs of values (elements) in the list memory.

Len Occupied space. Len 010, for example, means that the current list occupies 10 elements in the list memory.

[RF ON/OFF] Key

The RF output signal can be switched on and off with the [RF ON/OFF] key. This does not influence the current menu. When the output signal is switched off, "RF Off" appears in the header field with the level display. With RF Off, the 50 Ω source impedance is maintained.

IEC/IEEE-bus command `:OUTP OFF`

Modulation - General

The SML offers the following modulation types :

- Amplitude modulation (AM),
- Frequency modulation (FM),
- Phase modulation (ΦM),
- Pulse modulation PULSE (Option SML-B3),
- Stereo modulation STEREO (Option SML-B5),

For all modulations except vector modulation an internal or external modulation source can be used. For stereo modulation external analog R or L signals can be applied. The operation modes R, L, R=L, R=-L and R≠L are available. In addition the SML provides an S/P DIF input for externally generated digital stereo signals. Vector modulation requires external modulation signals.

Modulation Sources

Internal modulation source

For AM and FM/ΦM, an internal modulation generator (Lfgen) is available. For more information see section "LF Generator". ". The generator can also be used for analog stereo modulation. In this case the operation modes R, L, R=L, R=-L are available. For more information see section "Stereo Modulation (option SML-B5)".

For internal pulse modulation (option SML-B3), the instrument is equipped with a pulse generator. For more information see section "Pulse Generator".

External modulation source for AM, FM/ΦM) and PULSE

For external modulation, input connectors MOD (AM, FM/ΦM) and PULSE (Pulse modualtion) are available. External AM and FM/ΦM can be AC- or DC-coupled.

External modulation signals should have a voltage of V_p = 1 V (V_{rms} = 0.707 V) to maintain the displayed modulation depth or deviation.

External modulation sources for stereo modulation

For external analog stereo modulation, input connectors STEREO R and STEREO L are available at the rear panel of the SML .

External modulation signals should have a voltage of V_p = 1 V (V_{rms} = 0.707 V) to maintain the displayed frequency deviation.

For external digital stereo modulation the unsymmetrical BNC input connector S/P DIF is available (input impedance of 75 Ω). The external modulation signal should have a voltage of V_{pp} = 400 mV to V_{pp} = 5 V.

Extrenal modulation sources for vector modulation

For external vector modulation, input connectors I and Q are available at the rear panel of the SML(input impedances 50 Ω). To avoid the I/Q modulator being overdriven the input voltage should never exceed $\sqrt{I^2 + Q^2} = 0.5$ V.

Simultaneous Modulation

If vector modulation is deactivated then basically any combination of AM, FM/ΦM/stereo and pulse modulation is possible. There are restrictions only for FM,ΦM. and stereo. The same is true for activated vector modulation. Though, then there is an additional restriction for AM.

Two-tone AM and two-tone FM/ΦM can be selected via menu (Modulation - AM (FM/ΦM) - AM (FM/ΦM) Source - Two Tone).

Mutual Switch-Off of Modulation Types

As FM,ΦM and stereo use the same modulator, they cannot be activated simultaneously. They deactivate one another. In a similar way the same is true for AM and vector modulation. For AM the level control has to be activated while vector modulation requires the level control being deactivated.

Note: *IEC/IEEE-bus control according to SCPI does not allow the selection of the incompatible modulation types FM,ΦM and stereo or AM and vector modulation. With remote control, an error message is output when an attempt is made to activate these types of modulation (see Chapter 9).*

[MOD ON/OFF] Key

The various types of modulation can be switched on and off directly using the [MOD ON/OFF] key or via the Modulation menu. If switch-on is made using the [MOD ON/OFF] key, the modulation sources which are set in the modulation menus are used.

The [MOD ON/OFF] key can be effective either for all types of modulation or only for a selected modulation. The selection of modulation types for which the [MOD ON/OFF] key is to be effective is made in the Utilities – Mod Key menu.

If only one type of modulation is selected, it is switched on or off each time the [MOD ON/OFF] key is pressed.

If all modulation types are selected, the [MOD ON/OFF] key has the following effect:

- If at least one modulation type is active:
  Pressing the [MOD ON/OFF] key switches off all active modulation types. The modulation types which were active are stored.
- If no modulation type is active:
  Pressing the [MOD ON/OFF] key switches on the modulation types that were last switched off with this key.

Modulations

Amplitude Modulation

Settings for amplitude modulation can be made in the Modulation - AM menu.

Notes: – *The specified AM data are valid only up to 6 dB below the maximum level in each case. For level values exceeding this threshold, AM data are guaranteed only with linearly decreasing modulation depth.*

Menu selection: Modulation – AM

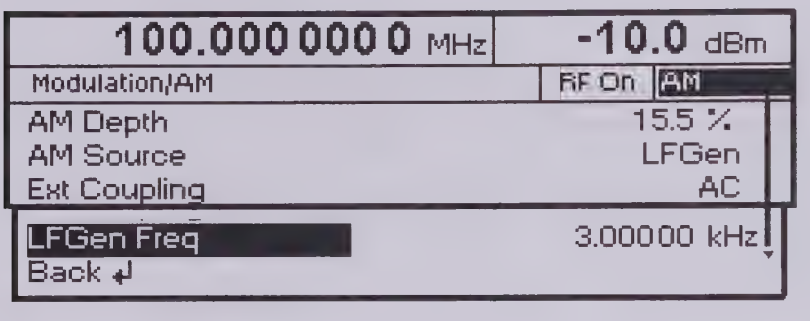


Fig. 4-8 Modulation - AM menu (preset setting)

AM Depth Input value of modulation depth
IEC/IEEE-bus command `:SOUR:AM 30PCT`

AM Source Selection of modulation source; Off, Ext, Lfgen or Two Tone are available.
IEC/IEEE-bus command `:SOUR:AM:SOUR EXT; STAT ON`

Ext Coupling Selection of AC or DC coupling with external modulation source
IEC/IEEE-bus command `:SOUR:AM:EXT:COUP AC`

LFGen Freq Selection of frequency of LF generator
IEC/IEEE-bus command `:SOUR:AM:INT:FREQ 1kHz`

Frequency Modulation

Settings for frequency modulation can be made in the Modulation - FM menu.

Menu selection: Modulation – FM

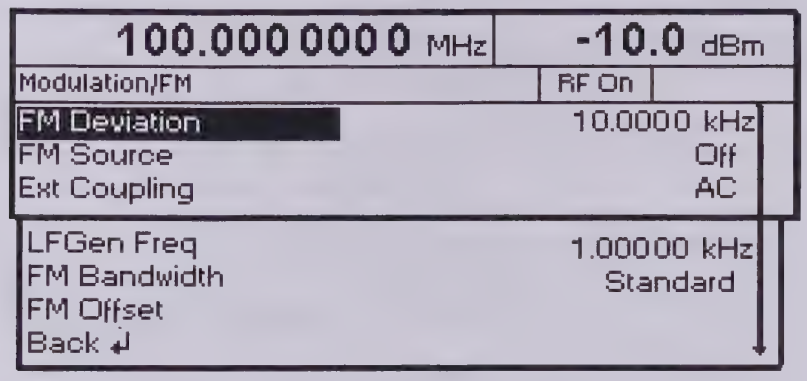


Fig. 4-9 Modulation - FM menu (preset setting)

FM Deviation Input value for deviation.
IEC/IEEE-bus command `:SOUR:FM 10kHz`

FM Source Switching on/off FM and selection of modulation source.
IEC/IEEE-bus commands `:SOUR:FM:SOUR EXT; STAT ON`

Ext Coupling Selection of AC or DC coupling for external input MOD.
IEC/IEEE-bus command `:SOUR:FM:EXT:COUP AC`

LFGen Freq Selection of frequency of LF generator.
IEC/IEEE-bus command `:SOUR:FM:INT:FREQ 1kHz`

FM Bandwidth Setting of bandwidth. Settings Standard and Wide are available.
IEC/IEEE-bus command `:SOUR:FM:BAND WIDE`

FM Offset This function is used to compensate DC offset.
IEC/IEEE-bus command `:CAL:FMOF?`

Phase Modulation

Settings for phase modulation can be made in the Modulation – ΦM menu.

Menu selection: Modulation – ΦM

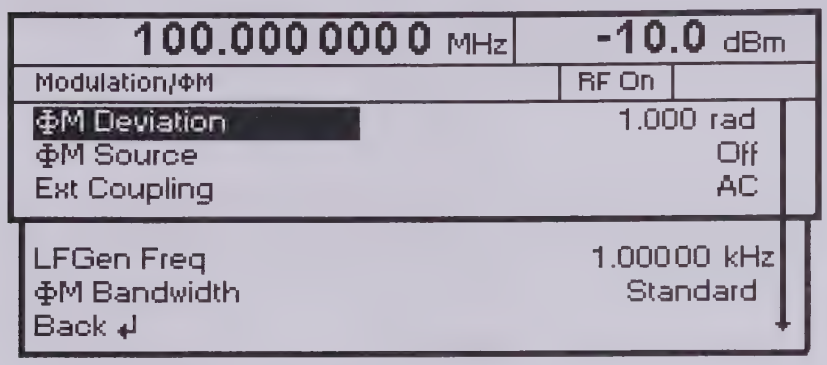


Fig. 4-10 Modulation - ΦM menu (preset setting)

ΦM Deviation Input value for deviation.
IEC/IEEE-bus command `:SOUR:PM 1 RAD`

ΦM Source Switching on/off PM and selection of modulation source.
IEC/IEEE-bus commands `:SOUR:PM:SOUR EXT; STAT ON`

Ext Coupling Selection of AC or DC coupling for external input MOD.
IEC/IEEE-bus command `:SOUR:PM:EXT:COUP AC`

LFGen Freq Selection of frequency of LF generator.
IEC/IEEE-bus command `:SOUR:PM:INT:FREQ 1kHz`

PM Bandwidth Setting of bandwidth. Settings Standard and Wide are available.
IEC/IEEE-bus command `:SOUR:PM:BAND WIDE`

Pulse Modulation (Option SML-B3)

The pulse modulator can be controlled from an external source or by an internal pulse generator. With external control, the external source feeds the pulse modulator directly. The envelope of the RF is identical to the control signal. With control by the internal pulse generator, the pulse shape of the pulse generator determines the envelope of the RF. The pulse delay, pulse width and pulse period can be set.

The polarity of pulse modulation is selectable. With Pulse Polarity = Normal, the RF level is switched on if HIGH level is present at the PULSE modulation input.

Settings for the pulse modulation and the pulse generator can be made in the Modulation - Pulse menu.

Menu selection: Modulation – Pulse

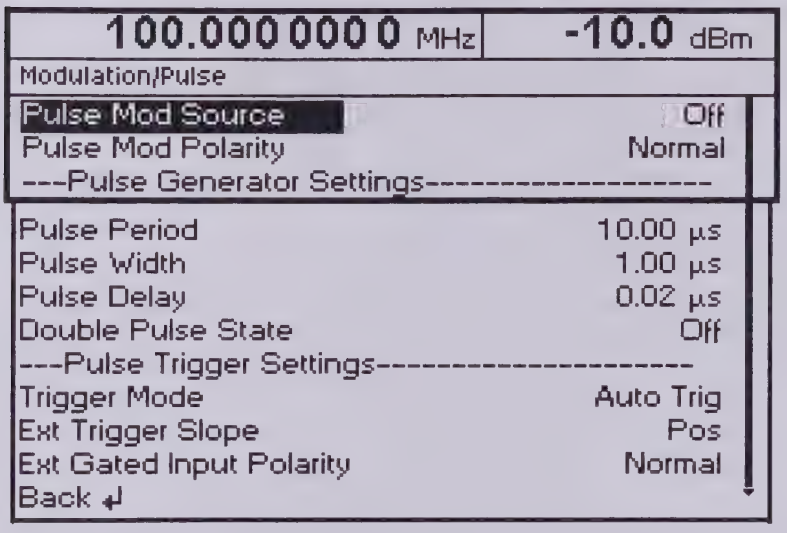


Fig. 4-11 Modulation - Pulse menu (preset setting), equipped with option SML-B3

Pulse Mod Source Selection of modulation source. Off, Ext and Pulse Gen are available.
IEC/IEEE-bus commands `:SOUR:PULM:SOUR EXT; STAT ON`

Pulse Mod Polarity Selection of polarity of modulation signal.
Normal The RF signal is on with HIGH level present.
Inverse The RF signal is suppressed with HIGH level present.
IEC/IEEE-bus command `:SOUR:PULM:POL NORM`

Pulse Period Input value of pulse period.
IEC/IEEE-bus command `:SOUR:PULS:PER 10us`

Pulse Width Input value of pulse width.
IEC/IEEE-bus command `:SOUR:PULS:WIDT 1us`

Pulse Delay Input value of single pulse delay. This value is indicated only if Double Pulse State is set to Off.
IEC/IEEE-bus command `:SOUR:PULS:DEL 1us`

Double Pulse Delay Delay between the two pulses of a double pulse. This value is indicated only if Double Pulse State is set to On.
IEC/IEEE-bus command `:SOUR:PULS:DOUB:DEL 1us`

Double Pulse State Switching on/off double pulse.

On Double pulse is switched on

Off Single pulse

IEC/IEEE-bus command `:SOUR:PULS:DOUB OFF`

Trigger Mode Selection of trigger mode.

Auto Trig The pulse generator is triggered automatically. The pulse period is as entered under Pulse Period.

Ext Trig The pulse generator is externally triggered. The pulse period is determined by an external signal at the PULSE input.

Ext Gated The pulse generator is triggered if the gate signal is active.

IEC/IEEE-bus command `:TRIG:PULS:SOUR AUTO`

Ext Trigger Slope Selection of active edge of external trigger signal.

Pos The pulse generator is triggered on the positive edge of the external signal.

Neg The pulse generator is triggered on the negative edge of the external signal.

IEC/IEEE-bus command `:TRIG:PULS:SLOP POS`

Ext Gated Input Polarity Definition of active level of gate signal (HIGH or LOW). Normal (HIGH) and Inverse (LOW) are available.

Pulse Generator

As an internal modulation source, the pulse generator offers the possibility of setting single and double pulses with variable pulse delay, pulse width and pulse period. The pulse generator can be triggered internally or by an external signal at the PULSE input. The following Pulse modi can be selected: Auto Trig, Ext Trig, and Ext Gated (see Fig. 4-12 to Fig. 4-14). The internal trigger signal is derived from the reference frequency and hence very stable. In the trigger mode Ext Trig, the positive or the negative edge can be used for triggering the pulse generator. In the trigger mode Ext Gated, the pulse generator is triggered as long as an active Gate signal arrives at the PULSE input.

The pulse generator can also be used as an independent unit, ie without the pulse modulator being controlled if the pulse modulation source (Pulse Source) is switched to OFF or EXT. The pulse can be tapped at the VIDEO output.

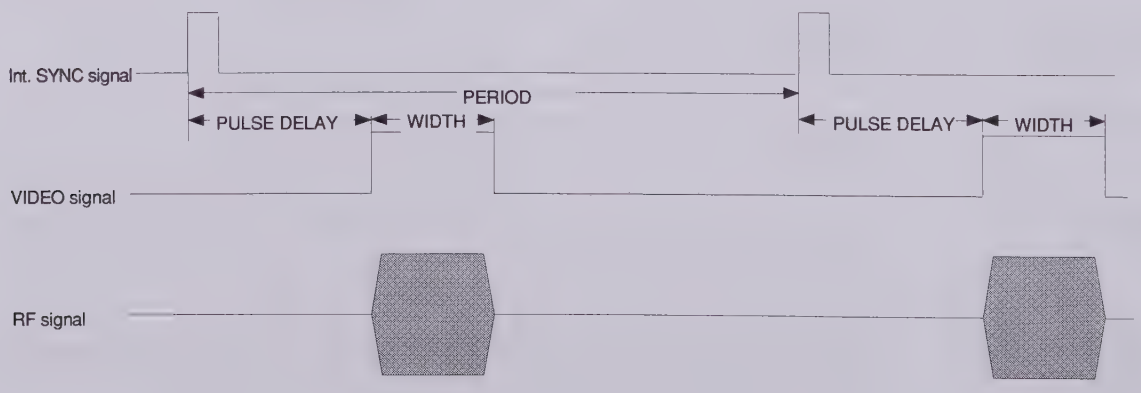


Fig. 4-12 Signal example 1: single pulse, Pulse mode = Auto Trig

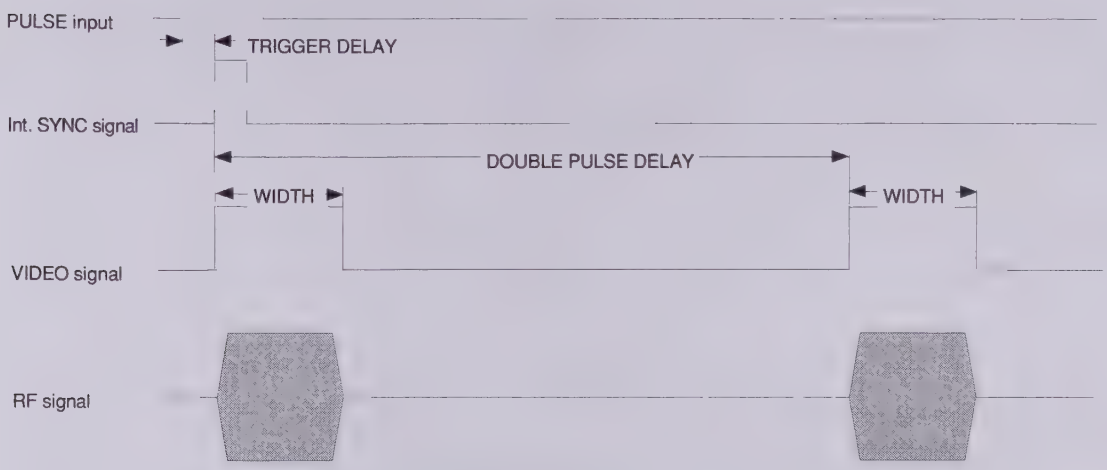


Fig. 4-13 Signal example 2: double pulse, Pulse mode = Ext Trig, Slope = Pos

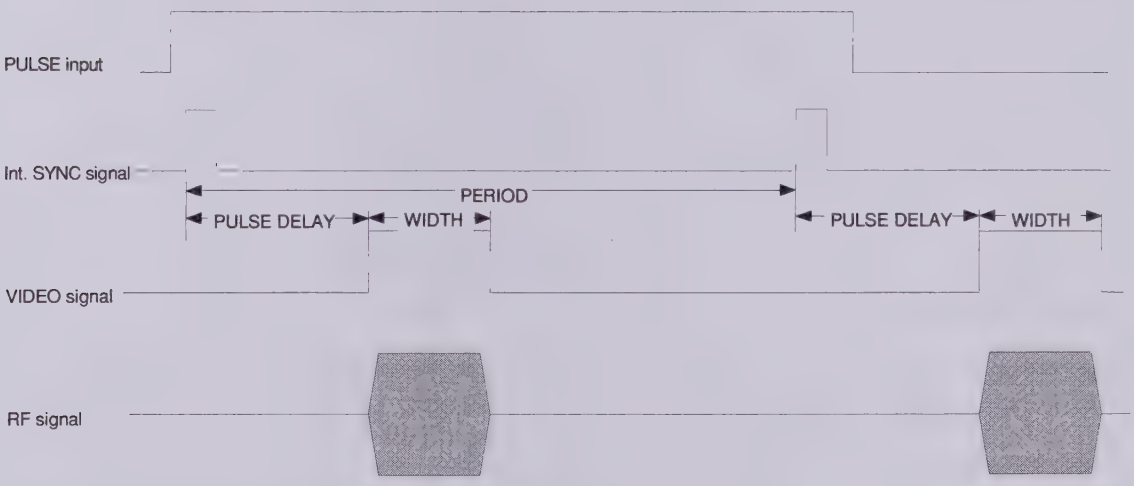


Fig. 4-14 Signal example 3: single pulse, Pulse Mode = Ext Gated

Stereo Modulation (Option SML-B5)

For stereo modulation external modulation sources or the internal LF generator can be used. For analog modulation signals, input connectors R and L are available at the rear panel. A digital stereo signal can be attached to the S/P DIF input (i. g. the output signal from the Audio Analyzer UPL). The above-mentioned different modulation sources cannot be used simultaneously.

In any case standard ARI and RDS signals can be generated, too.

Settings for stereo modulation can be made in the Modulation - Stereo menu.

Menu selection: Modulation – Stereo

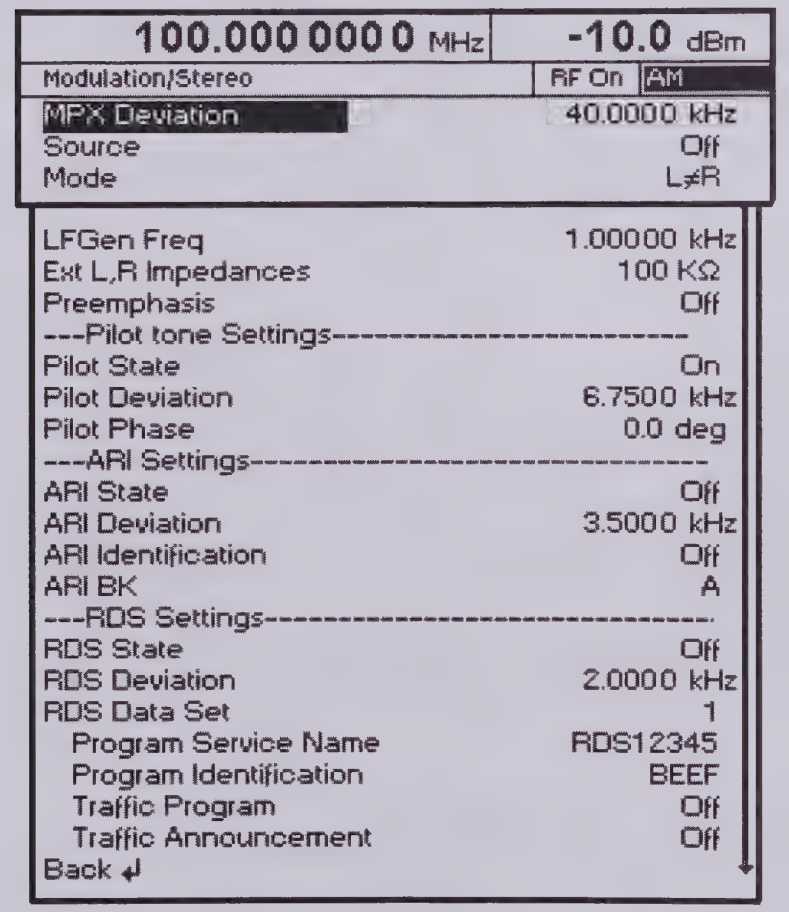


Fig. 4-14a Modulation - Stereo menu (preset setting), equipped with option SML-B5

Deviation Input value of the frequency deviation of the stereo signal.

.

IEC/IEEE-bus command `:SOUR:STER:DEV 40kHz`

Source

Selection of the modulation source. The sources cannot be used simultaneously.

.

Off	The stereo modulation is witched off.
Ext L, R	Selection of the L and R inputs for external analog modulation signals.
Ext S/P DIF	Selection of the S/P DIF input for the external digital modulation signal.
LF Gen	The modulation signal is generated by the internal LF generator.

IEC/IEEE-bus command `:SOUR:STER:SOUR LREX; STAT ON`

Mode

Selection of the operating mode.

L	Audio signal only in the left-hand channel.
R	Audio signal only in the right-hand channel.
L=R	Audio signals of same frequency and phase in both channels.
L=-R	Audio signal of same frequency but opposite phase in both channels.
L≠R	Different and independent audio signals in both channels (not possible with internal LF generator).

IEC/IEEE-bus command `:SOUR:STER:MODE LEQR`

LFGen Freq

Input value of the frequency of the LF generator.

IEC/IEEE-bus command `:SOUR:STER:INT:FREQ 1kHz`

Ext L,R Impedances

Selection of the input impedances of the analog audio inputs I and R. Both input impedances are switched simultaneously.

IEC/IEEE-bus command `:SOUR:STER:EXT:IMP 100kOhm`

Preemphasis

Selection of the preemphasis.

Off	Preemphasis switched off.
50 µs	Preemphasis 50 µs
75 µs	Preemphasis 75 µs

IEC/IEEE-bus command `:SOUR:STER:PRE 50us`

Pilot State

Switching on/off the pilot tone.

On	Pilot tone switched on
Off	Pilot tone switched off

IEC/IEEE-bus command `:SOUR:STER:PIL:STAT ON`

Pilot Deviation

Input value of the frequency deviation of the pilot tone.
IEC/IEEE-bus command `:SOUR:STER:PIL:DEV 6.75kHz`

Pilot Phase

Input value of the phase of the pilot tone (with respect to to 38 kHz subcarrier). .
IEC/IEEE-bus command `:SOUR:STER:PIL:PHAS 0 DEG`

ARI State

Switching on/off the ARI subcarrier..
On ARI subcarrier switched on
Off ARI subcarrier switched off
IEC/IEEE-bus command `:SOUR:STER:ARI:STAT ON`

ARI Deviation

Input value of the frequency deviation of the ARI subcarrier.
IEC/IEEE-bus command `:SOUR:STER:ARI:DEV 3.5kHz`

ARI Idendification

Selection between ARI broadcasting code (DK) and traffic area code (Bk). .
Off The area code and the broadcasting code are switched off.
DK The broadcasting code is activated.
BK The area code is activated.
BK+ DK The broadcasting code and area code are activated.
IEC/IEEE-bus command `:SOUR:STER:ARI:IDEN DK; STAT ON`

ARI BK

Selection of the standard traffic area codes.

A Traffic area code A
B Traffic area code B
C Traffic area code C
D Traffic area code D
E Traffic area code E
F Traffic area code F
IEC/IEEE-bus command: `:SOUR:STER:ARI:BK A`

RDS State

Switching on/ff the RDS functions.
On RDS switched on Off RDS switched off

IEC/IEEE-bus command `:SOUR:STER:STAT`

RDS Deviation

Input value of the frequency deviation of the RDS subcarrier.

IEC/IEEE-bus command `:SOUR:STER:RDS:DEV 2kHz`

RDS Data Set

Selection and activation of the RDS data set.

1 RDS data set 1
2 RDS data set 2
3 RDS data set 3
4 RDS data set 4
5 RDS data set 5

IEC/IEEE-bus command `:SOUR:STER:DAT DS1`

The RDS data sets cannot manually be entered. They have to be sent via the IEC/IEEC bus or the RS-232 interface.

Program Service Name

Indication of the program service name of the selected RDS data set (hexadecimal value OOOO bisFFFF).

Each RDS data set has its own program service name. It can only be modified over the IEC/IEEC bus or the RS-232 interface (see section "RDS commands").

Program Idendification

Indication of the program service name of the selected RDS data set (hexadecimal value OOOO bisFFFF). .

Each RDS data set has its own program identification. It can only be modified over the IEC/IEEC bus or the RS-232 interface (see section "RDS commands").

Traffic Program

Switching on/off traffic programm.

On Traffic program on
Off Traffic program off

IEC-Bus-Befehl `:SOUR:STER:RDS:TRAF:PROG ON`

Traffic Announcement

Switching on/off Traffic announcement

On Traffic announcement on
Off Traffic announcement off

IEC-Bus-Befehl `:SOUR:STER:RDS:TRAF:ANN ON`

RDS commands

The option SML-B5 supports all important RDS commands in accordance with IEC ??? The complete RDS command set of the option can be operated over the IEC/IEEE bus or the the RS-232 interface. Some basic RDS functions can also be found in the Modulation - Stereo menu and can manually be operated, too.

RDS settings via remote control: `[:SOURCe]:STEReo:DIRect "command string"`

RDS queries via remote control: `[:SOURCe]:STEReo:DIRect? ["command string"]`

RDS commands of the the Option SML-B5 (RDS / Stereo Coder)

Implemented commands:

Funtion	Description	Set command delimiter: CR	Read command delimiter: CR	Response delimiter: CR	Value range
PI=	Program Identification	PI=xxxx	PI?	xxxx	0000-FFFF
PS=	Program Service Name	PS = xxxxxxxx (char)	PS?	xxxxxxxx	8 ASCII signs
TP=	Traffic Program	TP=x	TP?	x	0|1
TA=	Traffic Announcement	TA=x	TA?	x	0|1
PTY=	Program Type	PTY=xx	PTY?	xx	00 to 31
PTYN=	Program Type Name	PTYN=xxxxxxxx	PTYN?	xxxxxxxx	8 ASCII signs
DI=	Decoder Information	DI=x	DI?	x	0-7
MS=	Music / Speech	MS=x	MS?	x	M|S
CT=	Clock Time sets RTC and CT = on	CT=XX:YY:ZZ,TT.MM.JJ XX= Stunde, YY= Minute, ZZ= Sekunde TT= Tag, MM= Monat, JJ=Jahr	CT?	XX:YY:ZZ,TT.MM.JJ	00:00:00,01.01.00 ... 23:59:59,31.12.85
CT=off	inhibits transmission of CT in RDS	CT=off			
BIN=	:binary test pattern: 0=binary mode off 1=00000000..., 2=11111111..., 3=0101.0101..., 4=11001100...	BIN=0|1|2|3|4			X = 0 to4
GS=	group sequence	GS=xx,xx,xx,xx... 1 to 36 Gruppen e. g.: GS=0A,2A,10A,14A,0A	GS?	xx,xx,xx,xx,xx...	XX = 2 or 3signs: 0A,1A,2A,.. to15B

Function	Description	Set command delimiter: CR	Read command delimiter: CR	Response delimiter: CR	Value range
DS=	datasetselection of the memory in the	DS=1 | 2 | 3 | 4 | 5	DS?		DS1 to DS5
STORE=	stores data in the FLASH memory	Store=x x = 1 to 5 user defined			
RDS=	RDS On|Off	RDS=0 | 1	RDS?		
RDS-PH=	RDS Phase	RDS-PHA=yyy	RDS-PHA?	yyy	000 to 359 °
RDS-DEV=		RDS-DEV=xxxx	RDS-DEV?	xxxx	
MPX-DEV=		MPX-DEV=xxxxx	MPX-DEV?	xxxxx	
SRC=		SRC=0 | 1 | 2 | 3	SRC?	X	
MODE=		MODE=1 | 2 | 3 | 4 | 5	MODE?	X	
IMP=		IMP=1 | 2	IMP?	X	
PRE=		PRE=0 | 1 | 2	PRE?	X	
PIL=		PIL=0 | 1	PIL?	X	
PIL-DEV=		PIL-DEV=xxxx	PIL-DEV?	xxxx	
PIL-PH=		PIL-PH=yxx	PIL-PH?	yxx	-50 to +50
ARI=		ARI=0 | 1	ARI?	x	
ARI-DEV=		ARI-DEV=xxxx	ARI-DEV?	xxxx	
ARI-ID=	Attention: ARI-ID=3 DK and BK on	ARI-ID=0 | 1 | 2 | 3	ARI-ID?	x	
BK=		BK=A | B | C | D | E | F	BK?	x	X=A toF
PRESET	sets preset values	PRESET			

Function	Description	Set command delimiter: CR	Read command delimiter: CR	Response delimiter: CR	Value range	
EON-PI=	Enhanced Other Networks	EON-PI=xxxx	EON-PI?	xxxx	0000 to FFFF	
EON-PS=		EON-PS=xxxx,yyyyyyyy xxxx = PI (hex) yyyyyyyy = PS (char)	EON-PS?xxxx	yyyyyyyy	x = EON PI 0000 to FFFF y = 8 Zeichen	
EON-TP=		EON-TP=xxxx,y	EON-TP?xxxx	y	y= 0|1	
EON-TA=		EON-TA=xxxx,y	EON-TA?xxxx	y	y= 0|1	
EON-PTY=		EON-PTY=xxxx,yy	EON-PTY?xxxx	yy	yy= 00-31	
EON-AFA=		EON-AFA=x,yyy.z,yyy.z,yyy.z	no query		see AF	
EON-AFB=		EON-AFB=x,yyy.z,yyy.z,yyy.z	no query		see AF	
EON-DEL=		EON-DEL=xxxx	no query		xxxx=PI (hex) 0000to FFFF	
RT=	radio text	RT=xx,y,ccccc…,cccc…xx = repeats single text , y = A/B FLAG (display refresh) ccc..= TEXT(max 64 char), 2 textspossible	RT?	xx,y,ccccc…,ccccc…	xx = 00 ... 15 y = 0|1 c = max 64 Char	no
AF=	Alternative Frequencies Max. 5 lists with 25 frequencies each	AF=x,yyy.z,yyy.z,yyy.z,.... x = N (new lists), + (add) Yyy.z = frequency	AFn? n = list no 1 to 5	x,yyy.z,yyy.z,yyy.z	x=N|+ Yyy.z = 89.5- 107.5	no

Example: Sending a RDS dataset to the SML

```
:STER:DIR "PI=0123"
:STER:DIR "PS=TEST1"
:STER:DIR "TP=0"
:STER:DIR "TA=0"
:STER:DIR "PTY=00"
:STER:DIR "DI=0"
:STER:DIR "MS=S"
:STER:DIR "STORE=1"
```

After downloading the commands of the above example and selecting RDS dataset 1 the following information is indicated on the display.

RDS Data Set	**1**
Program Service Name	**TEST1**
Program Identifikation	**0123**
Traffic Program	**Off**
Trafic Announcement	**Off**

Important: *Only after sending the STORE command (see last line in the above example) the dataset will be stored in the non-volatile memmory of the SML.*

The TP (Traffic Programm) and TA (Traffic Announcement) settings can manually be modified at any time as long as the dataset is displayed.
Example: Setting the clock

```
:STER:DIR "CT=14:35:00,15.05.02"
```

Using the system time of the PC which is acting as controller:

```
:STER:DIR "CT=system"
```

Examlpe: Sending of radio text (Hello world ...):

```
:STER:DIR "gs=0a,2a,2a,2a"

:STER:DIR "rt=01,0,Hello world!, this is the SML ..."
```

LF Generator

The frequency of internal modulation signals can be selected in one of the modulation menus (AM, FM/ΦM) or in the LF Output menu (cf. Chapter 4, Sections "Amplitude Modulation", "Frequency Modulation", "Phase Modulation" and "LF Output").

LF Output

The internal LF generator is available as a signal source for the LF output.

Settings for the LF output can be made in the LF Output menu.

Note: - *Any change to the frequency of the internal modulation generator in the LF Ou*

tput menu also affects the modulation for which the generator has been selected as a modulation source.

- *The sweep function of the LF generator can be activated in the Sweep - Lfgen menu.*
- *Inputs can only be made in V or mV.*

Menu selection: LF Output

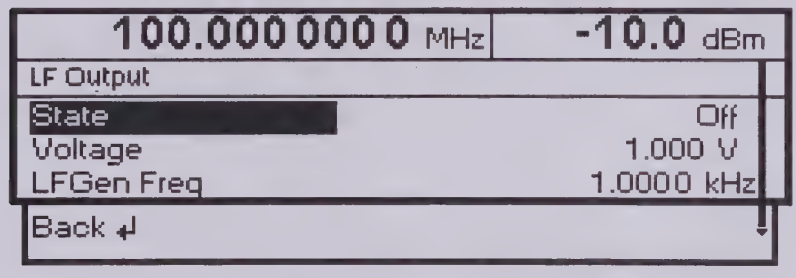


Fig. 4-15 LF Output menu (preset setting)

State Switching on/off LF output. This parameter has no effect on the modulation settings.

IEC/IEEE bus command `:OUTP2 ON`

Voltage Input value of output voltage of LF output. A peak voltage is to be entered here.

IEC/IEEE bus command `:OUTP2:VOLT 1V`

LFGen Freq Input value of frequency of internal modulation generator.

IEC/IEEE bus command `:SOUR2:FREQ 3kHz`

PULSE/VIDEO Output

The pulse generator output or video output is only available with Option SML-B3, pulse generator, cf. Section "Pulse Generator".

Menu selection: Pulse Output

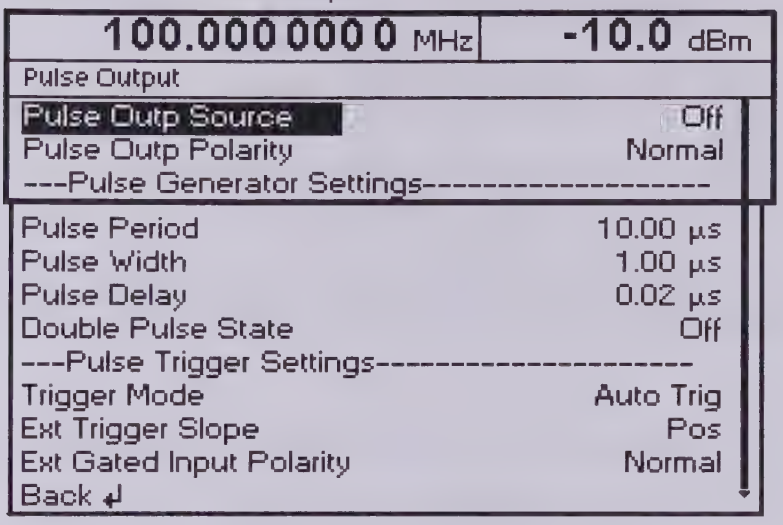


Fig. 4-19 Pulse Output menu

Pulse Output Source Switching on/off pulse source. Off, PulseGen or Video can be selected.
IEC/IEEE bus command `:OUTP3:SOUR OFF`

Pulse Output Polarity Selection of polarity of pulse signal.
Normal or Inverse can be selected.
IEC/IEEE bus command `:OUTP3:POL:PULS NORM`

Pulse Period Input value of pulse period.
IEC/IEEE-bus command `:SOUR:PULS:PER 10us`

Pulse Width Input value of pulse width.
IEC/IEEE-bus command `:SOUR:PULS:WIDT 1us`

Pulse Delay Input value of single pulse delay. This value is indicated only if Double Pulse State is set to Off.
IEC/IEEE-bus command `:SOUR:PULS:DEL 1us`

Double Pulse Delay Delay between the two pulses of a double pulse. This value is indicated only if Double Pulse State is set to On.
IEC/IEEE-bus command `:SOUR:PULS:DOUB:DEL 1us`

Double Pulse State Switching on/off double pulse.
On Double pulse is switched on
Off Single pulse
IEC/IEEE-bus command `:SOUR:PULS:DOUB OFF`

Trigger Mode

Selection of trigger mode:

Auto Trig The pulse generator is triggered automatically. The pulse period is as entered under Pulse Period.

Ext Trig The pulse generator is externally triggered. The pulse period is determined by an external signal at the PULSE input.

Ext Gated The pulse generator is triggered if the gate signal is active.

IEC/IEEE-bus command `:TRIG:PULS:SOUR AUTO`

Ext Trig Slope

Selection of active edge of external trigger signal.

Pos The pulse generator is triggered on the positive edge of the external signal.

Neg The pulse generator is triggered on the negative edge of the external signal.

IEC/IEEE-bus command `:TRIG:PULS:SLOP POS`

Ext Gated Input Polarity

Definition of active level of gate signal (HIGH or LOW). Normal (HIGH) and Inverse (LOW) are available.

Sweep

The SML features digital, step-by-step sweep for the following parameters:

- RF frequency
- LF frequency
- RF level

A sweep is set in four basic steps, which are demonstrated by the following example, ie the setting of a frequency sweep:

1. Set sweep range (Start Freq and Stop Freq or Center Freq and Span).
2. Select linear or logarithmic sweep (Spacing).
3. Select step size (Step Lin or Step Log) and dwell time (Dwell).
4. Switch on sweep (Mode set to Auto, Single, Step, Ext Single or Ext Step).

Setting the Sweep Range (Start Freq, Stop Freq, Center Freq, Span)

The sweep range for RF sweeps can be entered in two ways. Either the Start Freq and Stop Freq are entered or Center Freq and Span. Please note that the two parameter sets mutually affect each other as follows:

Start Freq altered:	Stop Freq	=	unaltered
	Center Freq	=	(Start Freq + Stop Freq)/2
	Span	=	(Stop Freq – Start Freq)
Stop Freq altered:	Start Freq	=	unaltered
	Center Freq	=	(Start Freq + Stop Freq)/2
	Span	=	(Stop Freq – Start Freq)
Center Freq altered:	Span	=	unaltered
	Start Freq	=	(Center Freq – Span/2)
	Stop Freq	=	(Center Freq + Span/2)
Span altered:	Center Freq	=	unaltered
	Start Freq	=	(Center Freq – Span/2)
	Stop Freq	=	(Center Freq + Span/2)

Selecting Linear or Logarithmic Sweep (Spacing Lin, Log)

Linear or logarithmic sweep can be selected with Spacing. For RF and LF sweeps, both the linear and logarithmic modes are selectable. For level sweeps, only the logarithmic mode is possible.

With logarithmic sweeps, the step size (Step) is equal to a constant fraction of the current setting. The logarithmic step size for RF and LF sweeps is entered in % and for level sweeps in dB.

Operating Modes (Mode)

The following sweep modes are available:

Auto Sweep from start point to stop point with automatic restart at start point. If another sweep mode was active prior to selection of the auto mode, the sweep is continued from the setting active at that time.

IEC/IEEE bus commands

RF sweep:	LF sweep:	Level sweep:
`SOUR:FREQ:MODE SWE`	`SOUR2:FREQ:MODE SWE`	`SOUR:POW:MODE SWE`
`SOUR:SWE:MODE AUTO`	`SOUR2:SWE:MODE AUTO`	`SOUR:SWE:POW:MODE AUTO`
`TRIG:SOUR AUTO`	`TRIG2:SOUR AUTO`	`TRIG:SOUR AUTO`

Single Single sweep from start point to stop point. The selection of Single does not start a sweep run. The sweep run is started by means of the Execute Single Sweep function, which is displayed below the Mode line.

IEC/IEEE bus commands

RF sweep:	LF sweep:	Level sweep:
`SOUR:FREQ:MODE SWE`	`SOUR2:FREQ:MODE SWE`	`SOUR:POW:MODE SWE`
`SOUR:SWE:MODE AUTO`	`SOUR2:SWE:MODE AUTO`	`SOUR:SWE:POW:MODE AUTO`
`TRIG:SOUR SING`	`TRIG2:SOUR SING`	`TRIG:SOUR SING`

Step Step-by-step, manual run within the sweep limits. Activating Step stops a running sweep and the cursor moves to the value indicated for Current. The sweep can now be controlled upwards or downwards in discrete steps using the rotary knob or the numeric keys.

IEC/IEEE-bus commands:

RF sweep:	LF sweep:	Level sweep:
`SOUR:FREQ:MODE SWE`	`SOUR2:FREQ:MODE SWE`	`SOUR:POW:MODE SWE`
`SOUR:SWE:MODE STEP`	`SOUR2:SWE:MODE STEP`	`SOUR:SWE:POW:MODE STEP`
`TRIG:SOUR SING`	`TRIG2:SOUR SING`	`TRIG:SOUR SING`

Ext Single Single sweep from start point to stop point as with Single, but triggered by an external signal

IEC/IEEE-bus commands:

RF sweep:	LF sweep:	Level sweep:
`SOUR:FREQ:MODE SWE`	`SOUR2:FREQ:MODE SWE`	`SOUR:POW:MODE SWE`
`SOUR:SWE:MODE AUTO`	`SOUR2:SWE:MODE AUTO`	`SOUR:SWE:POW:MODE AUTO`
`TRIG:SOUR EXT`	`TRIG2:SOUR EXT`	`TRIG:SOUR EXT`

Ext Step Step-by-step run controlled by an external trigger signal. Each trigger event triggers a single step.

IEC/IEEE-bus commands:

RF sweep:	LF sweep:	Level sweep:
`SOUR:FREQ:MODE SWE`	`SOUR2:FREQ:MODE SWE`	`SOUR:POW:MODE SWE`
`SOUR:SWE:MODE STEP`	`SOUR2:SWE:MODE STEP`	`SOUR:SWE:POW:MODE STEP`
`TRIG:SOUR EXT`	`TRIG2:SOUR EXT`	`TRIG:SOUR EXT`

Off Switching-off sweep mode.

IEC/IEEE-bus commands:

RF sweep:	LF sweep:	Level sweep:
`SOUR:FREQ:MODE CW`	`SOUR2:FREQ:MODE CW`	`SOUR:POW:MODE CW`

Sweep Inputs

TRIGGER An external signal at the rear input triggers the sweep in the Ext Single and Ext Step modes or stops the sweep in all modes.

RF Sweep

Settings for RF sweeps can be made in the Sweep - Freq menu.

Menu selection: Sweep – Freq

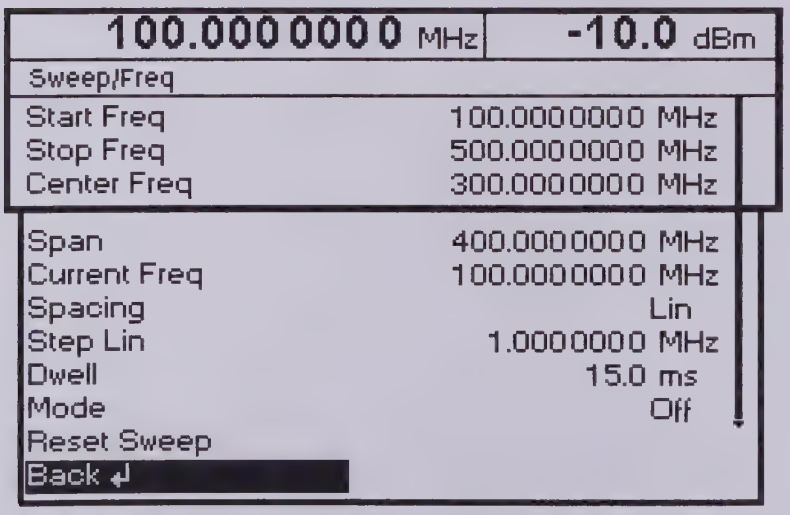


Fig. 4-20 Sweep - Freq menu

Start Freq
Input value of start frequency.
IEC/IEEE-bus command `:SOUR:FREQ:STAR 100MHz`

Stop Freq
Input value of stop frequency.
IEC/IEEE-bus command `:SOUR:FREQ:STOP 500MHz`

Center Freq
Input value of center frequency.
IEC/IEEE-bus command `:SOUR:FREQ:CENT 300MHz`

Span
Input value of span.
IEC/IEEE-bus command `:SOUR:FREQ:SPAN 400MHz`

Current Freq
Display of current frequency value.
In Step mode: input value of frequency.

Spacing
Selection of linear or logarithmic sweep.
IEC/IEEE-bus command `:SOUR:SWE:SPAC LIN`

Spacing Lin
Input value of step size. Depending on whether Spacing Lin or Log is selected, Step Lin or Step Log is displayed.
IEC/IEEE-bus command `:SOUR:SWE:STEP:LIN 1MHz`

Dwell
Input value of dwell time per step.
IEC/IEEE-bus command `:SOUR:SWE:DWEL 15ms`

Mode
Selection of sweep mode. See section "Operating Modes".
IEC/IEEE-bus commands
```
:SOUR:FREQ:MODE SWE;
:SOUR:SWE:MODE AUTO;
:TRIG:SOUR SING
```

Reset Sweep
Resets the start frequency.
IEC/IEEE-bus command `:ABOR`

Exec Single Sweep
Starts a single sweep. This function is displayed and is effective only if Single Mode is selected.
IEC/IEEE-bus command `:TRIG`

Level Sweep

Settings for level sweeps can be made in the Sweep - Level menu.

Menu selection: Sweep - Level

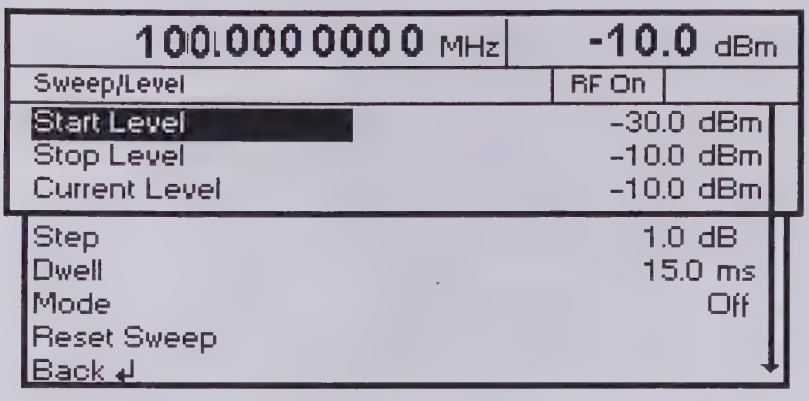


Fig. 4-21 Sweep - Level menu

Start Level
Input value of start level.
IEC/IEEE-bus command `:SOUR:POW:STAR -30dBm`

Stop Level
Input value of stop level.
IEC/IEEE-bus command `:SOUR:POW:STOP -10dBm`

Current Level
Display of current level.
In Step mode: Input value of level.

Step
Input value of step width.
IEC/IEEE-bus command `:SOUR:SWE:POW:STEP 1dB`

Dwell
Input value of dwell time per step.
IEC/IEEE-bus command `:SOUR:SWE:POW:DWEL 15ms`

Mode
Selection of sweep mode (see "Operating Modes").
IEC/IEEE-bus command
```
:SOUR:POW:MODE SWE;
:SOUR:SWE:POW:MODE AUTO;
:TRIG:SOUR SING
```

Reset Sweep
Sets the start level.
IEC/IEEE-bus command `:ABOR`

Exec Single Sweep
Starts a single sweep. This function is displayed and is effective only if Single Mode is selected.
IEC/IEEE-bus command `:TRIG`

LF Sweep

Settings for LF sweeps can be made in the Sweep - LFGen menu.

Menu selection: Sweep - LFGen

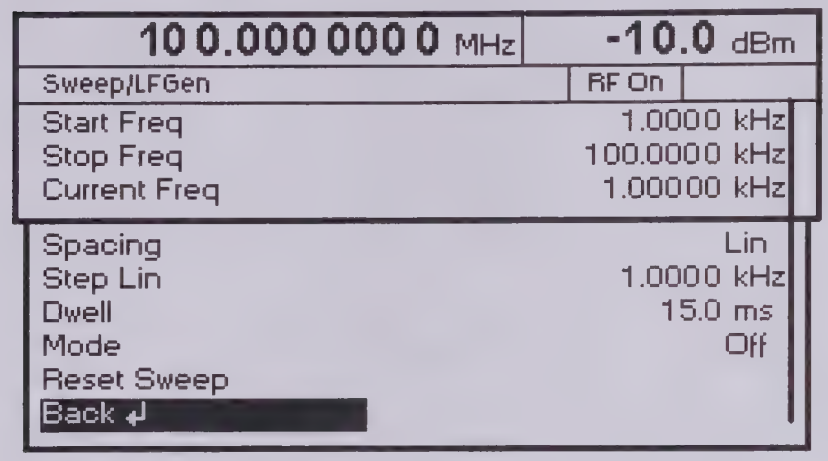


Fig. 4-22 Sweep - LFGen menu

Start Freq Input value of start frequency.
IEC/IEEE-bus command `:SOUR2:FREQ:STAR 1kHz`

Stop Freq Input value of stop frequency.
IEC/IEEE-bus command `:SOUR2:FREQ:STOP 100kHz`

Current Freq Display of current frequency value.
In Step mode: input value of frequency.

Spacing Selection of linear or logarithmic sweep.
IEC/IEEE-bus command `:SOUR2:SWE:SPAC LIN`

Step Lin Input value of step size.
IEC/IEEE-bus command `:SOUR2:SWE:STEP:LIN 1kHz`

Dwell Input value of dwell time per step.
IEC/IEEE-bus command `:SOUR2:SWE:DWEL 15ms`

Mode Selection of sweep mode (see "Operating Modes").
IEC/IEEE-bus command
```
:SOUR2:FREQ:MODE SWE
:SOUR2:SWE:MODE AUTO
:TRIG2:SOUR SING
```

Reset Sweep Sets the start frequency.
IEC/IEEE-bus command `:ABOR`

Exec Single Sweep Starts a single sweep. This function is displayed and is effective only if Single Mode is selected.
IEC/IEEE-bus command `:TRIG`

Utilities

The Utilities menu contains submenus for general functions not directly related to signal generation.

Menu selection: Utilities

Fig. 4-23 Utilities menu

Display

Menu Utilities – Display offers the contrast settings of the display. Setting range is 0 to 63.

Menu selection: Utilities - Display

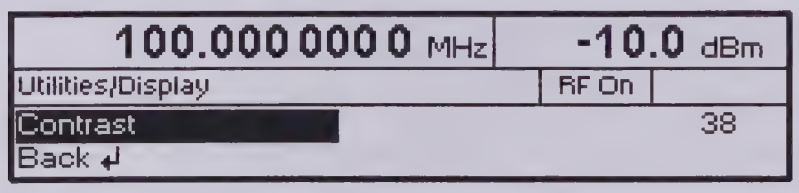


Fig. 4-24 Utilities - Display menu

System

Menu selection: Utilities – System

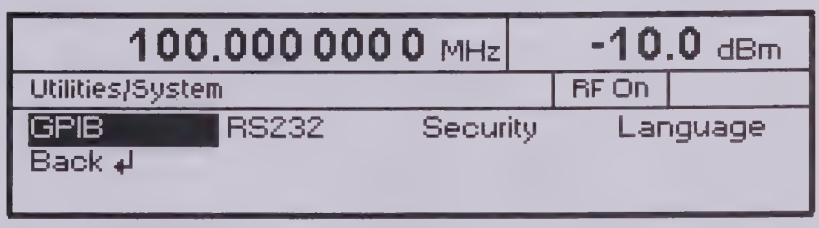


Fig. 4-25 Utilities - System menu

IEC/IEEE-Bus Address (System - GPIB)

Access to the remote-control address is offered by the Utilities - System - GPIB - Address submenu. The setting range is 1 to 30. The address is factory-set to 28.

Menu selection: Utilities – System – GPIB – Address

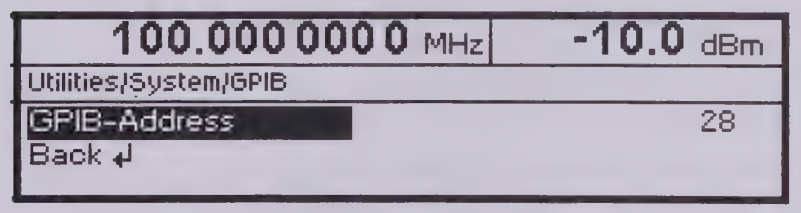


Fig. 4-26 Utilities – System – GPIB – Address menu

GPIB-Address Input value of IEC/IEEE-bus address.
IEC/IEEE-bus command `:SYST:COMM:GPIB:ADDR 28`

Parameters of RS-232-C Interface (System – RS232)

Settings for the configuration of the RS-232-C interface can be made in the Utilities – System – RS232 submenu. The pin assignment of the interface corresponds to that of a PC.

Menu selection: Utilities – System – RS232

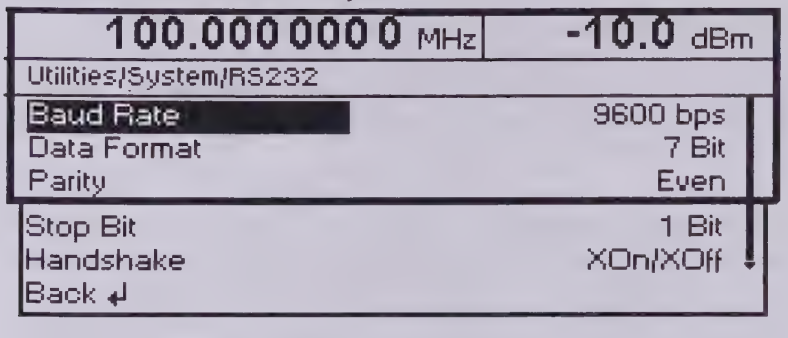


Fig. 4-27 Utilities – System – RS232 menu

Baud Rate Selection of transmission rate.

IEC/IEEE-bus command `:SYST:COMM:SER:BAUD 9600`

Data Format Indication of number of data bits. This value can be set to 7 or 8.

Parity Setting of parity. This setting defines the transmission mode for the parity bit for error protection. The following modes are available:

Odd odd parity
Even even parity
None no parity

IEC/IEEE-bus command `:SYST:COMM:SER:PAR ODD`

Stop Bit Indication of number of stop bits. This value can be set to 1 or 2.

Handshake Selection of handshake.

None No handshake

IEC/IEEE-bus command
`:SYST:COMM:SER:PACE NONE`
`:SYST:COMM:SER:CONT:RTS ON`

RTS/CTS Hardware handshake via interface lines RTS and CTS. This setting is to be preferred to the XON/XOFF setting if the host computer permits it.

IEC/IEEE-bus command `:SYST:COMM:SER:CONT:RTS RFR`

XON/XOFF Software handshake via ASCII codes 11h <XON> and 13h <XOFF>. This setting should not be used for binary data transmission and for baud rates higher than 9600 baud.

IEC/IEEE-bus command `:SYST:COMM:SER:PACE XON`

Note: *To avoid problems in the binary data tranmission, the RS-232-C interface should be set to 8 data bits, no parity and 1 stop bit. This data format is in line with the provisional IEEE P1174.*

Suppression of Indications and Clearing of Memories (System – Security)

For reasons of security, indications can be suppressed and memories cleared in the System – Security submenu.

Menu selection: Utilities – System – Security

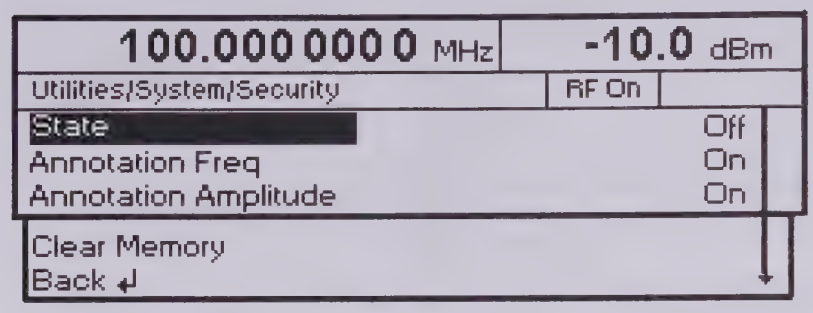


Fig. 4-28 Utilities – System – Security menu

State

Selection of Security status.

On — Locks the suppression of indications. Can be set only via the IEC/IEEE bus.

Off — Deactivates the interlock of the indication suppression. On the ON→OFF transition, the preset state is set, and all data such as stored settings, user correction and list settings are saved. Can be set only via the IEC/IEEE bus.

IEC/IEEE-bus command `:SYST:SEC OFF`

Annotation Freq

Off — All frequency indications are suppressed.

On — The frequency setting is displayed.

IEC/IEEE-bus command `:DISP:ANN:FREQ ON`

Annotation Amplitude

Off — All level indications are suppressed.

On — The level setting is displayed.

IEC/IEEE-bus command `:DISP:ANN:AMPL ON`

Clear Memory

Clearing of all stored data, such as stored settings and user correction settings.

Two IEC/IEEE-bus commands are required for this action:

IEC/IEEE-bus command `:SYST:SEC ON; SEC OFF`

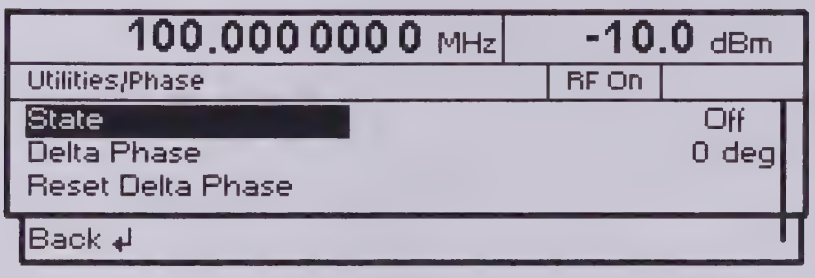
Indication of IEC/IEEE-Bus Language (System – Language)

The Utilities – System – Language submenu indicates the IEC/IEEE-bus language and the current SCPI version.

Phase of the Output Signal

The menu Utilities - Phase offers access to the phase setting of the RF output signal with respect to a reference signal of the same frequency. Activated FM, ϕM, stereo or vector modulation will be switched off if the phase setting will be switched on and vice versa.

Menu selection Utilities - Phase



4-29 Menu Utilities – Phase

State

Switching on/off phase setting.
IEC/IEEE-bus command `:SOUR:PHAS:STAT ON`

Delta Phase

Setting value of the phase.
IEC/IEEE-bus command `:SOUR:PHAS:30 DEG`

Reset Delta Phase

Sets the display of the Delta Phase to 0 without the phase of the output signal being influenced.
IEC/IEEE-bus command `:SOUR:PHAS:REF`

Internal/External Reference Frequency (RefOsc)

In the internal-reference mode, the internal reference signal with a frequency of 10 MHz is available at the 10 MHz REF socket on the rear of the instrument.

Signal level: V_{rms} (sine) > 0.5 V at 50 Ω.

In the external-reference mode, an external signal with a frequency of 1 MHz to 16 MHz (steps: 1 MHz) is to be fed to the 10 MHz +- 50HZ socket . The external-reference mode can be selected in the Utilities – RefOsc menu.

Signal level: V_{rms} = 0.5 V to 2 V

Settings for the reference frequency can be made in the RefOsc menu.

Menu selection: Utilities – RefOsc

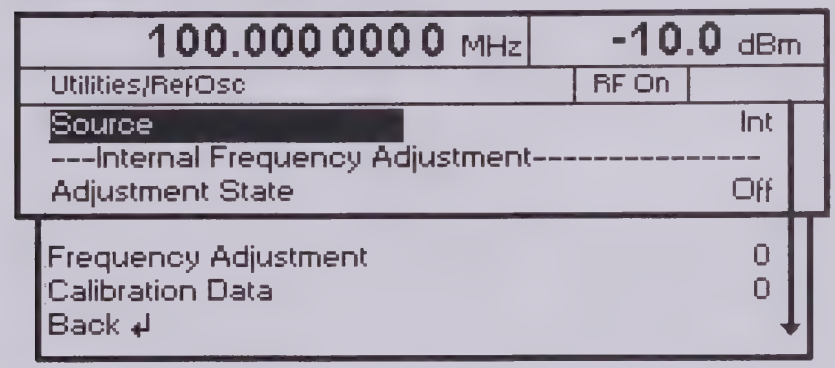


Fig. 4-30 Utilities – RefOsc menu (preset setting)

Source

Selection of operating mode.

Int Internal-reference mode

Ext External-reference mode

IEC/IEEE bus command `:SOUR:ROSC:SOUR INT`

Adjustment State

Off Tuning value of internal reference frequency as calibrated (see Utilities – Calib menu).

On Tuning value corresponding to value set under Frequency Adjustment. If option SML-B1 (Reference Oscillator OCXO) is installed, it is affected by these settings.

IEC/IEEE-bus command `:SOUR:ROSC:ADJ:STAT ON`

Frequency Adjustment

Input value in the range 0 to 4095 for setting the internal reference frequency.

IEC/IEEE bus command `:SOUR:ROSC:ADJ:VAL 2047`

Calibration Data

Display of the calibration value entered in the Utilities – Calib – RefOsc menu.

IEC/IEEE bus command `:CAL:ROSC?`

Menu selection:: Utilities - Phase

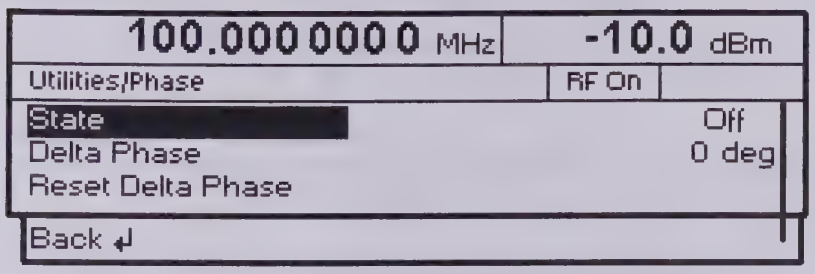


Fig 4-31 Menu Utilities - Phase

Passwords for Accessing Protected Functions (Protect)

Calibration and service functions are password-protected. To access these functions, passwords (6-digit numbers) have to be entered and confirmed with the [ENTER] key. These functions are automatically locked out on power-up of the instrument.

Password 1 deactivates the lock for the calibration of Main Loop, Level Preset, LFGen Level, Level.

Password 2 deactivates the lock for the calibration of RefOsc, IF Filter, Harm Filter, Mult Filter.

Password 3 factory internal

Password 4 factory internal

Access to protected functions is possible in the Utilities - Protect menu.

Menu selection: Utilities – Protect

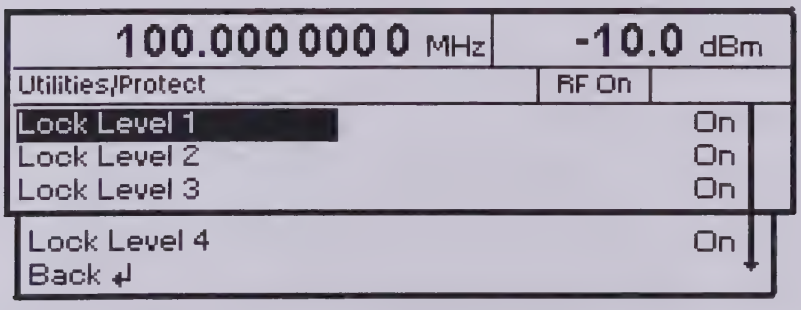


Fig. 4-32 Utilities - Protect menu (preset setting)

Lock Level x Activation/deactivation of lock.

On The lock is active.

IEC/IEEE-bus command `:SYST:PROT1 ON`

Off The entry of the password is enabled automatically. After entering the password, a pop-up menu is displayed. The lock can be deactivated by selection Off.

IEC/IEEE-bus command `:SYST:PROT1 OFF, 123456`

Calibration (Calib)

The Utilities - Calib menu offers access to calibration routines and correction values for the purpose of servicing.

Menu selection: Utilities - Calib

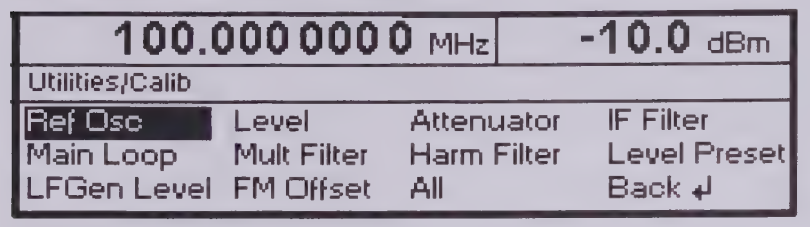


Fig. 4-33 Utilities - Calib menu (preset setting)

Seven internal calibration routines are run on the main board. The evaluated calibration values are stored on the module and if secured by Lock Level must be measured only when the unit is put into operation for the first time or circuit components are to be repaired.
To enable the calibrations, switch off Lock Level 1 in the Utilities-Protect menu (see section "Passwords for Accessing Protected Functions (Protect)" and enter password 123456.

If calibrations are to be performed, the unit is to be warmed up to its normal operating temperature. If a cold unit is calibrated when putting the unit into operation, the calibration has to be repeated with the unit at operating temperature.

Calibrations should be performed in the order indicated in Table 4-1. This is done automatically by the All function in the Calibrate menu.

Table 4-1 Overview of internal calibration routines

No.	Calibration	Function	Lock Level	Module/ component
1	IF Filter	Calibration of IF bandpass filter Calibration of IF gain	1	Mainboard/ synthesizer
2	Main Loop	Calibration of VCO preset voltage Calibration of main loop gain	1	Mainboard/ synthesizer
3	Mult Filter	Calibration of bandpass filters after multiplier	1	Mainboard/ synthesizer
4	Harm Filter	Calibration of harmonics filters	1	Mainboard/ output section
5	Level Preset	Calibration of operating point of AM modulator	1	Mainboard/ output section
6	LFGen Level	Calibration of LF generator level	1	Mainboard/ LF generator
7	FM Offset	Calibration of FMDC offsets	None	Mainboard/ synthesizer
	All	All internal calibrations are performed one after the other in the given order.		

For further information on Calibration of Ref Osc see SML service manual (Order No. 1090.3123.24). Level and attenuator do not need any settings.

Display of Module Versions (Diag - Config)

The versions and modification states of the modules installed can be displayed for servicing purposes. The modules can be displayed in the Utilities - Diag - Config submenu.

Menu selection: Utilities - Diag - Config

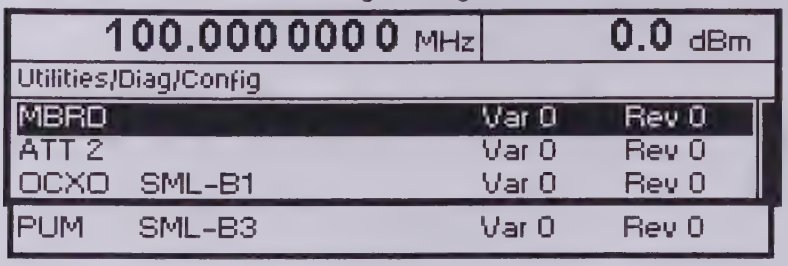


Fig. 4-34 Utilities - Diag - Config menu

IEC/IEEE-bus command `:DIAG:INFO:MOD?`

For further information see Service Manual.

Display of Voltages of Test Points (Diag - TPoint)

Access to internal test points is offered by the Diag - TPoint submenu. If a test point is switched on, the voltage is displayed in a window in the header field. For more detailed information see Service Manual.

Menu selection: Utilities - Diag - TPoint

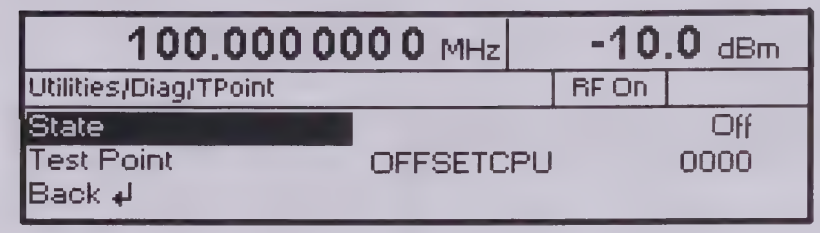


Fig. 4-35 Utilities - Diag - TPoint menu

State Switching on/off the voltage display in the header field.

Test Point Input value of test point.
IEC/IEEE-bus command `:DIAG:POIN? xxxx`

Display of Service Data (Diag - Param)

The Diag - Param submenu offers access to various parameters such as serial number, software version, operating-hours counter and overvoltage count.

Menu selection: Utilities - Diag - Param

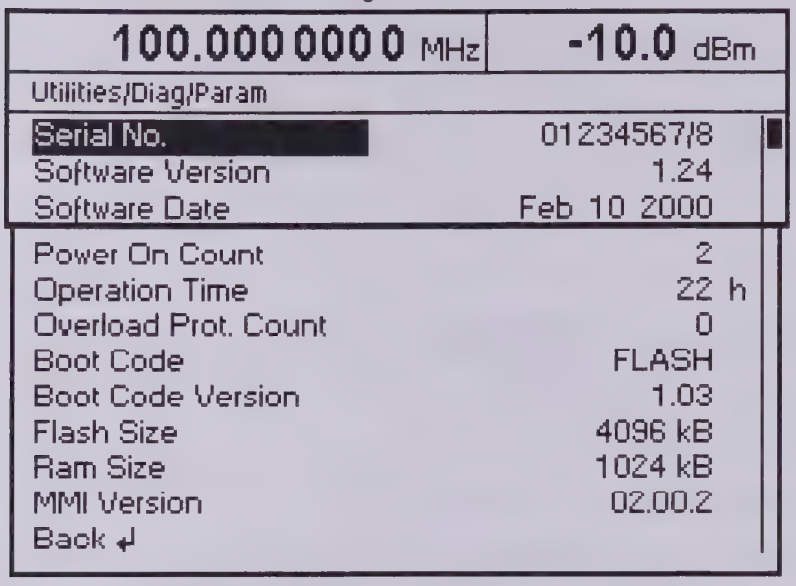


Fig. 4-36 Utilities - Diag - Param menu

For information on IEC/IEEE-bus commands see section "DIAGnostic - System".

Test

The SML carries out a selftest on switching on the instrument. On switching on, the RAM and ROM contents are checked.If an error is detected, this is indicated through a corresponding error message. The battery voltage of the non-volatile RAM is also checked on power-up. If the voltage falls below 2.5 V, storage of data is no longer guaranteed and a message is displayed on the screen.

The most important instrument functions are automatically monitored during operation.
If a faulty function is detected in the selftest, „Err“ is displayed in the status line. To identify the error, the ERROR menu, in which the error messages are entered, can be called by pressing the [ERROR] key (cf. Chapter 9, "Error Messages"). The tests can additionally be called via the menu.

Access to the tests is offered by the Utilities - Test menu.

Menu selection: Utilities – Test

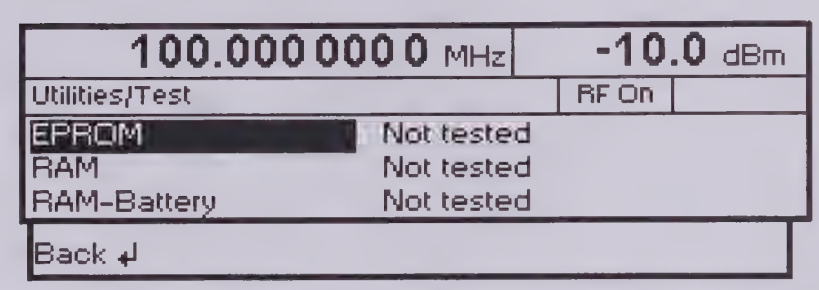


Fig. 4-36 Utilities - Test menu

EPROM Tests the EPROM. The test result is displayed in a window.
IEC/IEEE-bus-command `:TEST:ROM?`

RAM Tests the RAM. The test result is displayed in a window.
IEC/IEEE-bus-command `:TEST:RAM?`

RAM-Battery Tests the RAM battery. The test result is displayed in a window.
IEC/IEEE-bus-command `:TEST:BATT?`

Assigning Modulations to the [MOD ON/OFF] Key (ModKey)

Modulation types can be switched on/off in the modulation menus and with the [MOD ON/OFF] key.

It can be defined in the Utilities - ModKey menu for which modulation types the [MOD ON/OFF] key is to be effective. The key is effective either for all types of modulation or only for a selected modulation.

Function of [MOD ON/OFF] key if effective for only one type of modulation:
➢ The status (on/off) of the selected modulation type will change at each keypress.

Function of [MOD ON/OFF] key if effective for all types of modulation (All):
➢ If at least one type of modulation is switched on, pressing of the [MOD ON/OFF] key will switch off the modulation(s). The modulation types previously active are stored.

If switch-on is made with the [MOD ON/OFF] key, the modulation sources set in the modulation menus are used.

The modulation types to be switched on or off with the [MOD ON/OFF] key can be selected in the Utilities - ModKey menu.

Menu selection: Utilities - ModKey

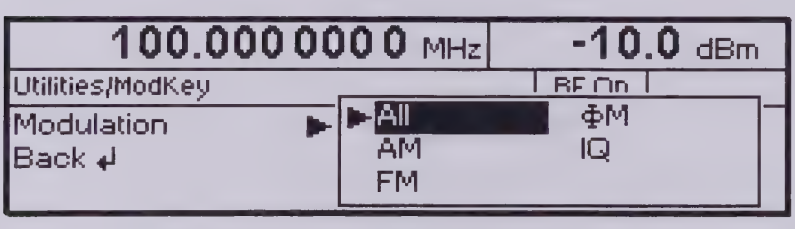


Fig. 4-38 Utilities - ModKey menu (preset setting)

Modulation Selection of modulation type(s) for which the [MOD ON/OFF] key is to be effective.

Note: *Preset switches off all modulations, sets this parameter to All and stores AM 30% as default setting.*

5 Remote Control – Basic Information

This chapter provides basic information on remote control, for example on the IEC/IEEE bus, RS-232-C interface, interface and device messages, command processing, status reporting system, etc.

The instrument is equipped with an IEC/IEEE-bus interface according to standard IEC 625.1/IEEE 488.1 and a RS-232-C interface. The connectors are located at the rear of the instrument and permit to connect a controller for remote control. The instrument supports the SCPI version 1994.0 (Standard Commands for Programmable Instruments). The SCPI standard is based on standard IEEE 488.2 and aims at the standardization of device-specific commands, error handling and the status registers.

For this section it is assumed that the user has basic knowledge of IEC/IEEE-bus programming and operation of the controller. A description of the interface commands will be found in the relevant manuals.
The requirements of the SCPI standard regarding command syntax, error handling and configuration of the status registers are explained in detail in the respective sections. Tables provide a fast overview of the bit assignment of the status registers. The tables are complemented by a comprehensive description of the status registers.
A description of commands is given in chapter 6. Programming examples for the main functions will be found in chapter 7.

Brief Instructions

The short and simple operating sequence given below permits fast putting into operation of the instrument and setting of its basic functions.

IEC/IEEE Bus

It is assumed that the IEC/IEEE-bus address, which is factory-set to 28, has not been changed.

1. Connect the instrument and the controller using the IEC/IEEE-bus cable.
2. Write and start the following program on the controller:

`CALL IBFIND("DEV1", generator%)`	Open port to instrument
`CALL IBPAD(generator%, 28)`	Transfer instrument address to controller
`CALL IBWRT(generator%, "*RST;*CLS")`	Reset instrument
`CALL IBWRT(generator%, "FREQ 1GHz")`	Set frequency to 1 GHz
`CALL IBWRT(generator%, "POW -7.3dBm")`	Set output level to –7.3 dBm
`CALL IBWRT(generator%, "OUTP:STAT ON")`	Switch RF output on
`CALL IBWRT(generator%, "AM:SOUR INT")`	Set AM modulation source Lfgen
`CALL IBWRT(generator%, "AM:INT:FREQ 15kHz")`	Set AM modulation frequency to 15 kHz
`CALL IBWRT(generator%, "AM 30PCT")`	Set AM modulation depth to 30%
`CALL IBWRT(generator%, "AM:STAT ON")`	Switch on AM

   An amplitude-modulated signal is now present at the output of the instrument.
3. To return to manual control, press the [LOCAL] key on the front panel.

RS-232-C Interface

It is assumed that the configuration of the RS-232-C interface of the unit has not yet been changed.

1. Connect the unit and the controller using the null modem cable.
2. Enter the following command on the controller to configure the controller interface:
   mode com1: 9600, n, 8, 1
3. Create the following ASCII file on the controller:

	Switch instrument to remote control (RETURN)
`*RST;*CLS`	Reset instrument
`FREQ 1GHz`	Set frequency to 1 GHz
`POW -7.3dBm`	Set output level to –7.3 dBm
`OUTP:STAT ON`	Switch on RF output
`AM 30PCT`	Set AM modulation depth to 30%
`AM:STAT ON`	Switch on AM
	(RETURN)

4. Transfer the ASCII file to the instrument via the RS-232-C interface. Enter the following command on the controller:
   copy <filename> com1:
   An amplitude-modulated signal is now present at the output of the instrument.
5. To return to manual control, press the [LOCAL] key on the front panel.

Switchover to Remote Control

On power-up, the instrument is always in the manual control mode ("LOCAL" state) and can be operated via the front panel.

The instrument is switched to remote control ("REMOTE" state) as follows:

IEC/IEEE-bus: when it receives an addressed command from the controller.

RS-232-C interface: when it receives a carriage return <CR> (=0Dh) or a line feed <LF> (=0Ah) from the controller.

During remote control, operation via the front panel is disabled. The instrument remains in the remote state until it is reset to the manual state via the front panel or via the IEC/IEEE bus. Switching from manual to remote control and vice versa does not affect the instrument settings.

Remote Control via IEC/IEEE Bus

Setting the Device Address

The IEC/IEEE-bus address of the instrument is factory-set to 28. It can be changed manually in the Utilities - System - GPIB-Address menu or via the IEC/IEEE bus. Addresses 1 to 30 are permissible.

Manually:

- Call Utilities - System - GPIB-Address menu.
- Enter desired address.
- Terminate input using the [1x/ENTER] key.

Via IEC/IEEE bus:

```
CALL IBFIND("DEV1", generator%)          Open port to instrument
CALL IBPAD(generator%, 28)               Transfer old address to controller
CALL IBWRT(generator%, "SYST:COMM:GPIB:ADDR 20")
                                         Set instrument to new address
CALL IBPAD(generator%, 20)               Transfer new address to controller
```

Indications during Remote Control

The remote control state is indicated by "Remote" being displayed in the STATUS line. In the REMOTE state, the STATUS page is always displayed.
"Locked" indicates that the [LOCAL] key is disabled, ie switchover to manual control can only be made via the IEC/IEEE bus. If "Unlocked" is displayed, switchover to manual control can be made with the [LOCAL] key.

Return to Manual Operation

Return to manual operation can be made via the front panel or the IEC/IEEE bus.

Manually: ➢ Press [LOCAL] key.

Note:

- *Before switchover, command processing must be completed as otherwise switchover to remote control is effected immediately.*
- *The [LOCAL] key can be disabled by the universal command LLO in order to prevent unintentional switchover. In this case, switchover to manual control is only possible via the IEC/IEEE bus.*
- *The [LOCAL] key can be enabled again by deactivating the REN control line of the IEC/IEEE bus.*

Via IEC/IEEE bus:

```
...
CALL IBLOC(generator%)          Set instrument to manual control
...
```

Remote Control via RS-232-C Interface

Setting the Transmission Parameters

To enable error-free and correct data transmission, the parameters of the instrument and the controller should have the same setting. To prevent any problems during binary data transmission, the RS-232-C interface should be set to 8 data bits, "No parity" and 1 stop bit. This data format corresponds to the IEEE P1174 draft standard.
The baud rate and handshake can be manually changed in the Utilities - System - RS232 menu.

➢ Call Utilities – System - RS232 menu.

➢ Select desired baud rate and handshake.

➢ Terminate input using the [1x/ENTER] key.

Indications during Remote Control

The remote control state is indicated by "Remote" in the STATUS line. In the REMOTE state, the STATUS page is always displayed.

Return to Manual Operation

Return to manual operation can be made via the front panel.

➢ Press [*LOCAL*] key.

Note: *Before switchover, command processing must be completed as otherwise switchover to remote control is effected immediately.*

Messages

The messages transferred via the data lines of the IEC/IEEE bus can be divided into two groups:

- **interfaces messages** and
- **device messages**

No interface messages are defined for the RS-232-C interface.

Interface Messages

Interface messages are transferred on the data lines of the IEC/IEEE bus, the ATN control line being active. They are used for communication between the controller and the instrument and can only be sent by a controller which has the IEC/IEEE-bus control. Interface commands can be subdivided into

- **universal commands** and
- **addressed commands**

Universal commands act on all devices connected to the IEC/IEEE bus without previous addressing, addressed commands only act on devices previously addressed as listeners. The interface messages relevant to the instrument are listed in the section "Interface Messages" below.
Some control characters are defined for the control of the RS-232-C interface, see section "Interface Functions".

Device Messages (Commands and Device Responses)

Device messages are transferred on the data lines of the IEC/IEEE bus, the ATN control line not being active. ASCII code is used. The device messages are largely identical for the two interfaces (IEC/IEEE bus and RS-232-C).
A distinction is made according to the direction in which device messages are sent on the IEC/IEEE bus:

- **Commands** are messages the controller sends to the instrument.
  They operate the device functions and request information.
  Commands are subdivided according to two criteria:

  1. According to the effect they have on the instrument:

  Setting commands cause instrument settings such as reset of the instrument or setting the output level to 1 V.

  Queries cause data to be provided for output (queries) on the IEC/IEEE bus, eg for device identification or polling of the active input.

  2. According to their definition in standard IEEE 488.2:

  Common Commands are exactly defined as to their function and notation in standard IEEE 488.2. They refer to functions such as the management of the standardized status registers, reset and selftest.

  Device-specific commands refer to functions depending on the features of the instrument such as frequency setting. A majority of these commands has also been standardized by the SCPI committee.

- **Device responses** are messages the instruments sends to the controller in reply to a query. They may contain measurement results or information on the instrument status.

The structure and syntax of device messages are described in the following section.

Structure and Syntax of Device Messages

Introduction to SCPI

SCPI (Standard Commands for Programmable Instruments) describes a standard command set for programming instruments, irrespective of the type of instrument or manufacturer. The objective of the SCPI consortium is to standardize the device-specific commands to a large extent. For this purpose, a model was developed which defines identical functions of a device or of different devices. Command systems were generated which are assigned to these functions. Thus it is possible to address identical functions with identical commands. The command systems are of a hierarchical structure. Fig. 5-1 illustrates this tree structure using a section of command system SOURce, which operates the signal sources of the devices. The other examples concerning syntax and structure of the commands are derived from this command system.
SCPI is based on standard IEEE 488.2, ie it uses the same basic syntax elements as well as the common commands defined in this standard. Part of the syntax of the device responses is defined in greater detail than in standard IEEE 488.2 (see section "Responses to Queries").

Structure of Commands

Commands consist of a header and, in most cases, one or several parameters. The header and the parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, eg a blank). Headers may consist of several key words. Queries are formed by appending a question mark directly to the header.

Note: *The commands used in the following examples are not in every case implemented in the instrument.*

Common commands

Common (device-independent) commands consist of a header preceded by an asterisk "*" and of one or several parameters, if any.

Examples:

`*RST`	RESET, resets the instrument
`*ESE 253`	EVENT STATUS ENABLE, sets the bits of the event status enable register
`*ESR?`	EVENT STATUS QUERY, queries the contents of the event status register

Device-specific commands

The following examples are general, they are not necessarily available with SML.

Hierarchy:

Device-specific commands are of a hierarchical structure (see Fig. 5-1). The different levels are represented by combined headers. Headers of the highest level (root level) have only one key word. This key word denotes a complete command system.

Example: `SOURce`
This key word denotes the `SOURce` command system.

For commands of lower levels, the complete path has to be specified, starting on the left with the highest level, the individual key words being separated by a colon ":".

Example: `SOURce:FM:EXTernal:COUPling AC`

This command is at the fourth level of the SOURce system. It selects AC coupling of the external signal source.

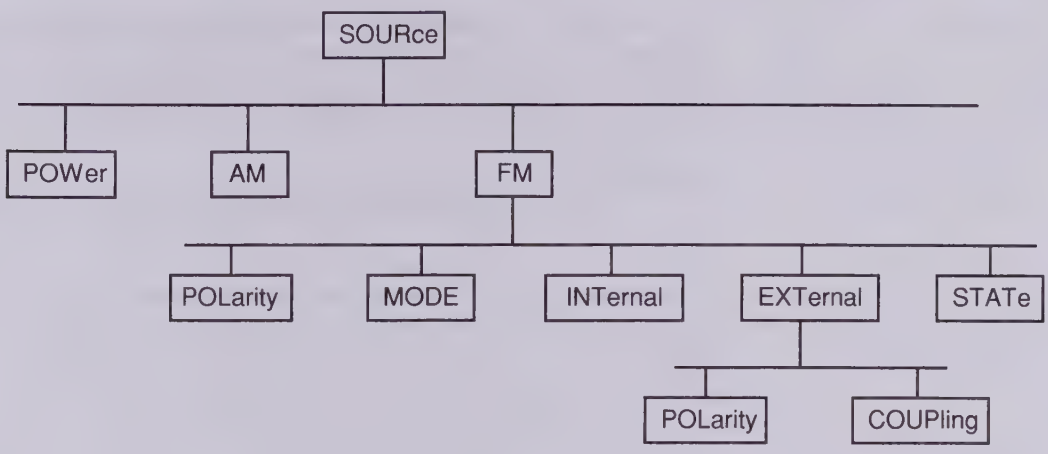


Fig. 5-1 Tree structure of SCPI command systems using the SOURce system as an example

Some key words occur at several levels within one command system. Their effect depends on the structure of the command, that is to say, at what position of the header of a command they are inserted.

Example: `:SOURce:FM:POLarity NORMal`
This command contains the key word POLarity at the third command level. It defines the polarity between the modulator and the modulation signal.

Example `:SOURce:FM:EXTernal:POLarity NORMal`
This command contains the key word POLarity at the fourth command level. It defines the polarity between the modulation voltage and the resulting direction of the modulation only for the external signal source indicated.

Optional key words:

Some command systems permit certain key words to be optionally inserted into the header or omitted. These key words are marked in the description by square brackets. The instrument must recognize the full command length for reasons of compatibility with the SCPI standard. Some commands can be considerably shortened by omitting optional key words.

Example: `[SOURce]:POWer[:LEVel][:IMMediate]:OFFSet 1`
This command immediately sets the offset of the signal to 1 dB. The following command has the same effect:

`POWer:OFFSet 1`

Note: *An optional key word must not be omitted if its effect is specified in greater detail by means of a numerical suffix.*

Long and short form:

Key words have a long form and a short form. Either the long form or the short form may be entered, other abbreviations are not permissible.

Example: `STATus:QUEStionable:ENABle 1= STAT:QUES:ENAB 1`

Note: *The short form is characterized by upper-case letters, the long form corresponds to the complete word. Upper-case and lower-case notation only serve the above purpose, the device itself does not make any difference between upper-case and lower-case letters.*

Parameters:

A parameter must be separated from the header by a "white space". If a command includes several parameters, they are separated by a comma ",". Some queries permit the parameters MINimum, MAXimum and DEFault to be entered. For a description of these parameter types see section "Parameters".

Example: `SOURce:POWer:ATTenuation? MAXimum` Response: `60`
This query requests the maximum value for the attenuation.

Numerical suffix:

If a device has several functions or features of the same kind, eg inputs, the desired function can be selected by appending a suffix to the command. Entries without suffix are interpreted like entries with the suffix 1.

Example: `SOURce2:FREQuency:MODE CW`
This command determines the operating mode for the Frequency Subsystem.

Structure of Command Lines

A command line may contain one or several commands. It is terminated by <New Line>, <New Line> with EOI or EOI together with the last data byte. QuickBASIC automatically produces EOI together with the last data byte.

Several commands in a command line are separated by a semicolon ";". If the next command belongs to a different command system, the semicolon is followed by a colon.

Example:
```
CALL IBWRT(generator%, "SOURce:POWer:CENTer MINimum;:OUTPut:ATTenuation 10")
```

This command line contains two commands. The first command belongs to the SOURce system and defines the center frequency of the output signal. The second command belongs to the OUTPut system and sets the attenuation of the output signal.

If successive commands belong to the same system and thus have one or several levels in common, the command line can be abbreviated. To this end, the second command (after the semicolon) is started with the level that lies below the common levels (see also Fig. 5-1). The colon following the semicolon must be omitted in this case.

Example:
```
CALL IBWRT(generator%, "SOURce:FM:MODE LOCKed;:SOURce:FM:INTernal:FREQuency 1kHz")
```

This command line is represented in its full length and contains two commands separated from each other by the semicolon. The two commands belong to the SOURce command system, subsystem FM, ie they have two common levels.
To abbreviate the command line, the second command is started with the level below `SOURce:FM`. The colon after the semicolon is omitted.

The abbreviated form of the command line reads as follows:

```
CALL IBWRT(generator%, "SOURce:FM:MODE LOCKed;INTernal:FREQuency 1kHz")
```

However, a new command line always has to be started with the complete path.

Example:
```
CALL IBWRT(generator%, "SOURce:FM:MODE LOCKed")
CALL IBWRT(generator%, "SOURce:FM:INTernal:FREQuency 1kHz")
```

Responses to Queries

For each setting command, a query is defined unless explicitly specified otherwise. The query is formed by adding a question mark to the setting command in question. Responses to queries to the SCPI standard are partly subject to stricter rules than responses to the IEEE 488.2 standard.

1. The requested parameter is transmitted without header.
   Example: `SOURce:EXTernal:COUPling?` Response: `AC`

2. Maximum values, minimum values and all further quantities requested via a special text parameter are returned as numerical values.
   Example: `FREQuency? MAX` Response: `10E3`

3. Numerical values are output without a unit. Physical quantities are referred to the basic units or to the units set with the Unit command.
   Example: `FREQuency?` Response: `1E6` for 1 MHz

4. Truth values (Boolean parameters) are returned as 0 (for Off) and 1 (for On).
   Example: `OUTPut:STATe?` Response: `1`

5. Text (character data) is returned in a short form.
   Example: `SOURce:FM:SOURce?` Response: `INT`

Parameters

The following examples are general, they are not necessarily available with SML.
Most commands require a parameter to be specified. Parameters must be separated from the header by a "white space". Permissible parameters are numerical values, Boolean parameters, text, character strings and block data. The parameter type required for a given command and the permissible range of values are specified in the command description.

Numerical values

Numerical values can be entered in any form, ie with sign, decimal point and exponent. Values exceeding the resolution of the instrument are rounded up or down. The mantissa may comprise up to 255 characters, the exponent must be in the value range -32 000 to 32 000. The exponent is preceded by an "E" or "e". Specifying the exponent alone is not permissible. In the case of physical quantities, the unit can be entered. Permissible unit prefixes are G (giga), MA (mega, MOHM and MHz being also permissible), K (kilo), M (milli), U (micro) and N (nano). If no unit is entered, the basic unit is used.

Example: `SOURce:FREQuency 1.5 kHz = SOURce:FREQuency 1.5E3`

Special numerical values

The texts MINimum, MAXimum, DEFault, UP and DOWN are interpreted as special numerical values.
In the case of a query, the numerical value is returned.

Example: Setting command: `SOURce:VOLTage MAXimum`
Query: `SOURce:VOLTage?` Response: `15`

MIN/MAX — MINimum and MAXimum denote the minimum and the maximum value.

DEF — DEFault denotes a preset value stored in an EPROM. This value conforms to the default setting as called by the *RST command.

UP/DOWN — UP/DOWN increases or decreases the numerical value by one step. The step width can be defined via an allocated step command for each parameter which can be set via UP/DOWN (see List of Commands, chapter 6).

INF/NINF — INFinity, Negative INFinity (NINF) represent the numerical values –9.9E37 or 9.9E37, respectively. INF and NINF are only sent as device responses.

NAN — Not A Number (NAN) represents the value 9.91E37. NAN is only sent as a device response. This value is not defined. Possible causes are the division of zero by zero, the subtraction of infinite from infinite and the representation of missing values.

Boolean Parameters

Boolean parameters represent two states. The ON state (logically true) is represented by ON or a numerical value unequal to 0. The OFF state (logically untrue) is represented by OFF or the numerical value 0. In the case of a query, 0 or 1 is returned.

Example: Setting command: `SOURce:FM:STATe ON`
Query: `SOURce:FM:STATe?` Response: `1`

Text

Text parameters follow the syntactic rules for key words, ie they can be entered using a short or a long form. Like any other parameter, they must be separated from the header by a "white space". In the case of a query, the short form of the text is returned.

Example: Setting command: `:OUTPut:FILTer:TYPE EXTernal`
Query: `:OUTPut:FILTer:TYPE?` Response: `EXT`

Strings

Strings must always be entered in inverted commas (' or ").

Example: `SYSTem:LANGuage "SCPI"` or
`:SYSTem:LANGuage 'SCPI'`

Block data

Block data are a transmission format which is suitable for the transmission of large amounts of data. A command with a block data parameter has the following structure:

Example: `HEADer:HEADer #45168xxxxxxxx`

The data block is preceded by the ASCII character #. The next number indicates how many of the following digits describe the length of the data block. In the example, the four following digits indicate the length to be 5168 bytes. This is followed by the data bytes. During the transmission of the data bytes, all End or other control signs are ignored until all bytes are transmitted. Data elements comprising more than one byte are transmitted with the byte being the first which was specified by the SCPI command "`FORMat:BORDer`".

The format of the binary data within a block depends on the IEC/IEEE-bus command. The commands

```
:SOURce:CORRection:CSET:DATA:FREQuency
:SOURce:CORRection:CSET:DATA:POWer
:SYSTem:MSEQuence:DWELl
:SYSTem:MSEQuence:RCL
```

use the IEEE 754 format for double precision floating point numbers. Each number is represented by 8 bytes.

Example:

a# = 125.345678E6
b# = 127.876543E6

```
CALL IBWRT(generator%, "SOURCE:CORRECTION:CSET:DATA:FREQ
#216" + MKD$(a#) + MKD$(b#))
```

- '#' in the command string introduces the binary block,
- '2' indicates that 2 digits specifying the length will follow next,
- '16' is the length of the binary block (in bytes), here: 2 double precision floating point numbers of 8 bytes each.
- The binary data follow. Since the function IBWRT requires a text string, MKD$ is used for type conversion.

The following ASCII format has the same effect:

```
CALL IBWRT(generator%, "SOURCE:CORRECTION:CSET:DATA:FREQ
125.345678E6, 127.876543E6")
```

Overview of Syntax Elements

Following is an overview of syntax elements.

:	The colon separates the key words of a command. In a command line the separating semicolon marks the uppermost command level.
;	The semicolon separates two commands of a command line. It does not alter the path.
,	The comma separates several parameters of a command.
?	The question mark forms a query.
*	The asterix marks a common command.
"	Quotation marks introduce a string and terminate it.
#	ASCI character # introduces block data.
	A "white space" (ASCII-Code 0 to 9, 11 to 32 decimal, e.g. blank) separates header and parameter.

Instrument Model and Command Processing

The instrument model shown in Fig. 5-2 was created with a view to the processing of IEC/IEEE-bus commands. The individual components work independently of each other and simultaneously. They communicate with each other by means of messages.

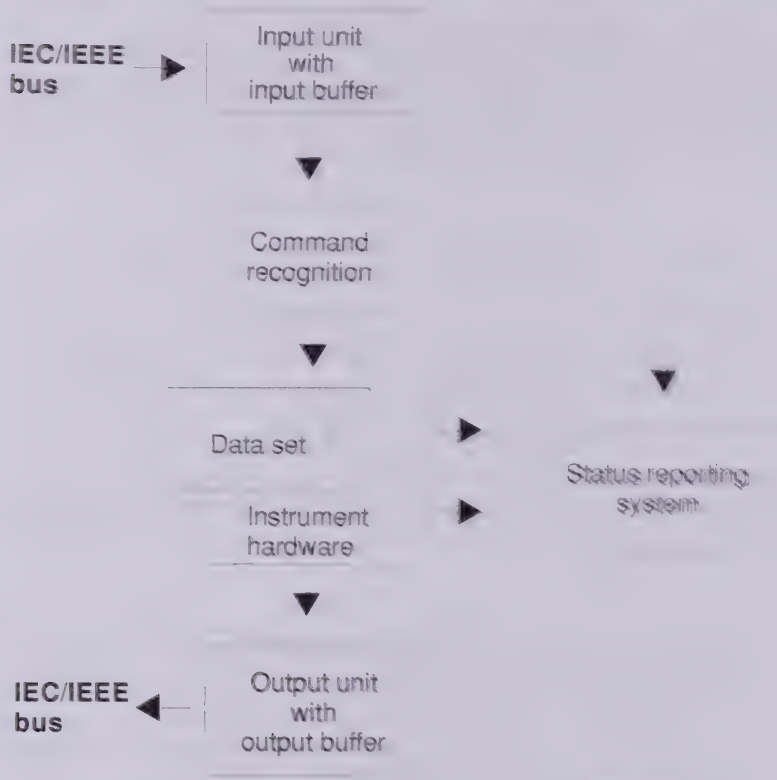


Fig. 5-2 Device model for remote control via the IEC/IEEE bus

Input Unit

The input unit receives commands character by character from the IEC/IEEE bus and stores them in the input buffer. The input buffer has a size of 256 characters. The input unit sends a message to the command recognition when the input buffer is full or when it receives a terminator, <PROGRAM MESSAGE TERMINATOR>, as defined in IEEE 488.2, or the interface message DCL.
If the input buffer is full, the IEC/IEEE-bus traffic is stopped and the data received up to then are processed. After this, the IEC/IEEE-bus traffic is continued. If, on receipt of a terminator, the input buffer is not full, the input unit can receive the next command during command recognition and execution. Receipt of a DCL command clears the input buffer and immediately initiates a message to the command recognition.

Command Recognition

The command recognition analyzes the data from the input unit in the order the data are received. Only DCL commands are serviced with priority, whereas GET commands (Group Execute Trigger), for example, are processed only after the previously received commands. Each recognized command is immediately transferred to the data set but without being executed there at once.

Syntactic errors in commands are detected here and transferred to the status reporting system. The rest of a command line following a syntax error is further analyzed and processed as far as possible.

If the command recognition recognizes a terminator or a DCL command, it requests the data set to set the commands now also in the instrument hardware. After this, it is immediately ready to continue processing commands. This means that new commands can be processed while the hardware is being set ("overlapping execution").

Data Set and Instrument Hardware

The term "instrument hardware" is used here to designate the part of the instrument which actually performs the instrument functions: signal generation, measurement, etc. The controller is not included.

The data set is a detailed reproduction of the instrument hardware in the software.

IEC/IEEE-bus setting commands cause an alteration of the data set. The data set management enters the new values (eg frequency) into the data set but passes them on to the hardware only upon request by the command recognition. As this is only effected at the end of a command line, the sequence of setting commands in the command line is not relevant.

The data are only checked for compatibility among one another and with the instrument hardware immediately before they are transferred to the instrument hardware. If it is found that an execution is not possible, an "execution error" is signalled to the status reporting system. All alterations mad to the data set are cancelled, and the instrument hardware is not reset. Due to the delayed checking and hardware setting it is permissible however that impermissible instrument states are briefly set within a command line without an error message being produced. At the end of the command line, however, a permissible instrument state must be attained.

Before the data are passed on to the hardware, the settling bit in the STATus:OPERation register is set. The hardware makes the settings and resets the bit when the new state has settled. This procedure can be used for synchronization of command processing.

IEC/IEEE-bus queries cause the data set management to send the desired data to the output unit.

Status Reporting System

The status reporting system collects information on the instrument state and makes it available to the output unit upon request. A detailed description of the structure and function is given in section "Status Reporting System".

Output Unit

The output unit collects the information requested by the controller and output by the data set management. The output unit processes the information in accordance with the SCPI rules and makes it available in the output buffer. The output buffer has a size of 256 characters. If the requested information exceeds this size, it is made available in portions without this being recognized by the controller.

If the instrument is addressed as a talker without the output buffer containing data or awaiting data from the data set management, the output unit returns the error message "Query UNTERMINATED" to the status reporting system. No data are sent on the IEC/IEEE bus. The controller waits until it has reached its time limit. This procedure is specified by SCPI.

Command Sequence and Command Synchronization

As mentioned above, overlapping execution is possible for all commands. Likewise, the setting commands of a command line are not necessarily processed in the order in which they are received.

To ensure that commands are carried out in a specific order, each command must be sent in a separate command line, ie with a separate IBWRT() call.
To prevent overlapping execution of commands, one of commands `*OPC`, `*OPC?` or `*WAI` has to be used. Each of the three commands causes a certain action to be triggered only after the hardware has been set and has settled. The controller can be programmed to wait for the respective action to occur (see Table 5-1).

Table 5-1 Synchronization by means of *OPC, *OPC? and *WAI

Command	Action after the hardware has settled	Programming of controller
*OPC	Sets the operation-complete bits in the ESR	- Setting of bit 0 in the ESE - Setting of bit 5 in the SRE – Waiting for a service request (SRQ)
*OPC?	Writes a "1" into the output buffer	Addressing of instrument as a talker
*WAI	Continues the IEC/IEEE-bus handshake. The handshake is not stopped.	Sending of next command

An example of command synchronization will be found in section 7, "Programming Examples".

Status Reporting System

The status reporting system (see Fig. 5-4) stores all information on the current operating state of the instrument, for example on any errors that have occurred. This information is stored in status registers and in an error queue. The status registers and the error queue can be queried via the IEC/IEEE bus.

The information is of a hierarchical structure. The highest level is formed by the status byte (STB) register defined in IEEE 488.2 and the associated service request enable (SRE) mask register. The STB register receives information from the standard event status register (ESR) which is also defined in IEEE 488.2 with the associated standard event status enable (ESE) mask register, and from the registers STATus:OPERation and STATus:QUEStionable which are defined by SCPI and contain detailed information on the instrument.

The status reporting system further comprises the IST flag ("Individual STatus") with the parallel poll enable (PPE) register allocated to it. The IST flag, like the SRQ, combines the entire instrument state in a single bit. The function fulfilled by the PPE register for the IST flag corresponds to that fulfilled by the SRE for the service request.

The output buffer contains the messages the instrument returns to the controller. The output buffer is not part of the status reporting system but determines the value of the MAV bit in the STB register and is therefore shown in Fig. 5-4.

Structure of an SCPI Status Register

Each SCPI register consists of five parts each of 16 bits width which have different functions (see Fig. 5-3). The individual bits are independent of each other, ie each hardware status is assigned a bit number which is valid for all five parts. For example, bit 3 of the STATus:OPERation register is assigned to the hardware status "Wait for trigger" for all five parts. Bit 15 (the most significant bit) is set to zero for all five parts. This allows the controller to process the contents of the register parts as positive integer.

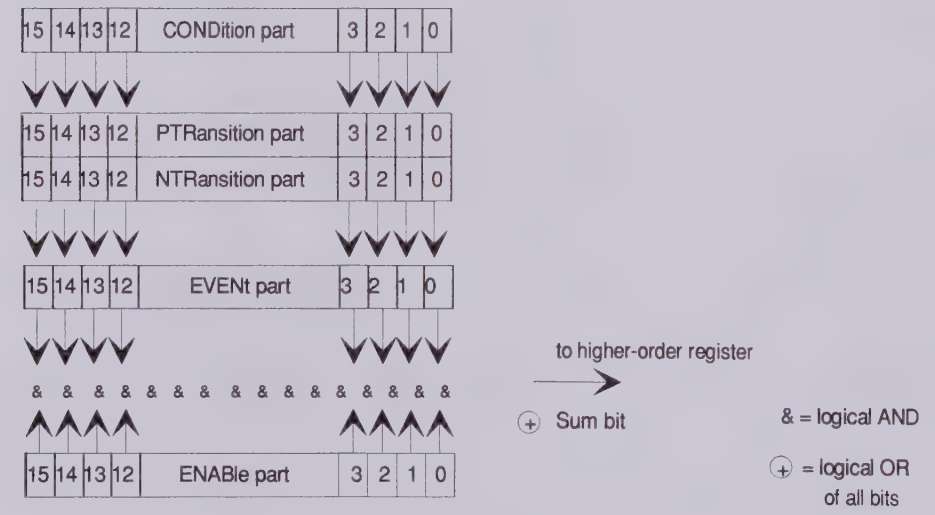

15 14 13 12 CONDition part 3 2 1 0
15 14 13 12 PTRansition part 3 2 1 0
15 14 13 12 NTRansition part 3 2 1 0
15 14 13 12 EVENt part 3 2 1 0
& & & & & & & & & & & & & &
15 14 13 12 ENABle part 3 2 1 0
to higher-order register
⊕ Sum bit
& = logical AND
⊕ = logical OR of all bits

Fig. 5-3 Status register model

CONDition part

The CONDition part is directly written to by the hardware or the sum bit of the next lower register. Its contents reflects the current instrument status. This register part can be read only but not written to or cleared. Reading does not affect it contents.

PTRansition part

The Positive Transition part acts as an edge detector. If a bit of the CONDition part changes from 0 to 1, the status of the associated PTR bit determines whether the EVENt bit is set to 1.
PTR bit = 1: the EVENt bit is set.
PTR bit = 0: the EVENt bit is not set.
This part can be written to and read. Reading does not affect its contents.

NTRansition part

The Negative Transition part likewise acts as an edge detector. If a bit of the CONDition part changes from 1 to 0, the status of the associated NTR bit determines whether the EVENt bit is set to 1.
NTR bit = 1: the EVENt bit is set.
NTR bit = 0: the EVENt bit is not set.
This part can be written to and read. Reading does not affect its contents.

With the above two edge register parts, the user can define what status transition of the CONDition part (none, 0 to 1, 1 to 0 or both) is to be stored in the EVENt part.

EVENt part

The EVENt part indicates whether an event has occurred since it was read the last time; it is the "memory" of the CONDition part. It indicates only those events that were passed on by the edge filters. The EVENt part is continuously updated by the instrument. This part can be read only. Upon reading, its contents is set to zero. In linguistic usage, the EVENt part is often treated as equivalent to the complete register.

ENABle part

The ENABle part determines whether the associated EVENt bit contributes to the sum bit (see below). Each bit of the EVENt part is ANDed with the associated ENABle bit (symbol '&'). The results of all logical operations of this part are passed on to the sum bit via an OR function (symbol '+').
ENABle-Bit = 0: the associated EVENt bit does not contribute to the sum bit.
ENABle-Bit = 1: if the associated EVENT bit is "1", the sum bit is set to "1" as well.
This part can be written to and read. Reading does not affect its contents.

Sum bit

As mentioned above, the sum bit is obtained from the EVENt part and the ENABle part for each register. The result is entered as a bit of the CONDition part into the next higher register.
The instrument automatically generates a sum bit for each register. It is thus ensured that an event, for example a PLL that has not locked, can produce a service request throughout all hierarchical levels.

Note: *The service request enable (SRE) register defined in IEEE 488.2 can be taken as the ENABle part of the STB if the STB is structured in accordance with SCPI. Analogously, the ESE can be taken as the ENABle part of the ESR.*

Overview of Status Registers

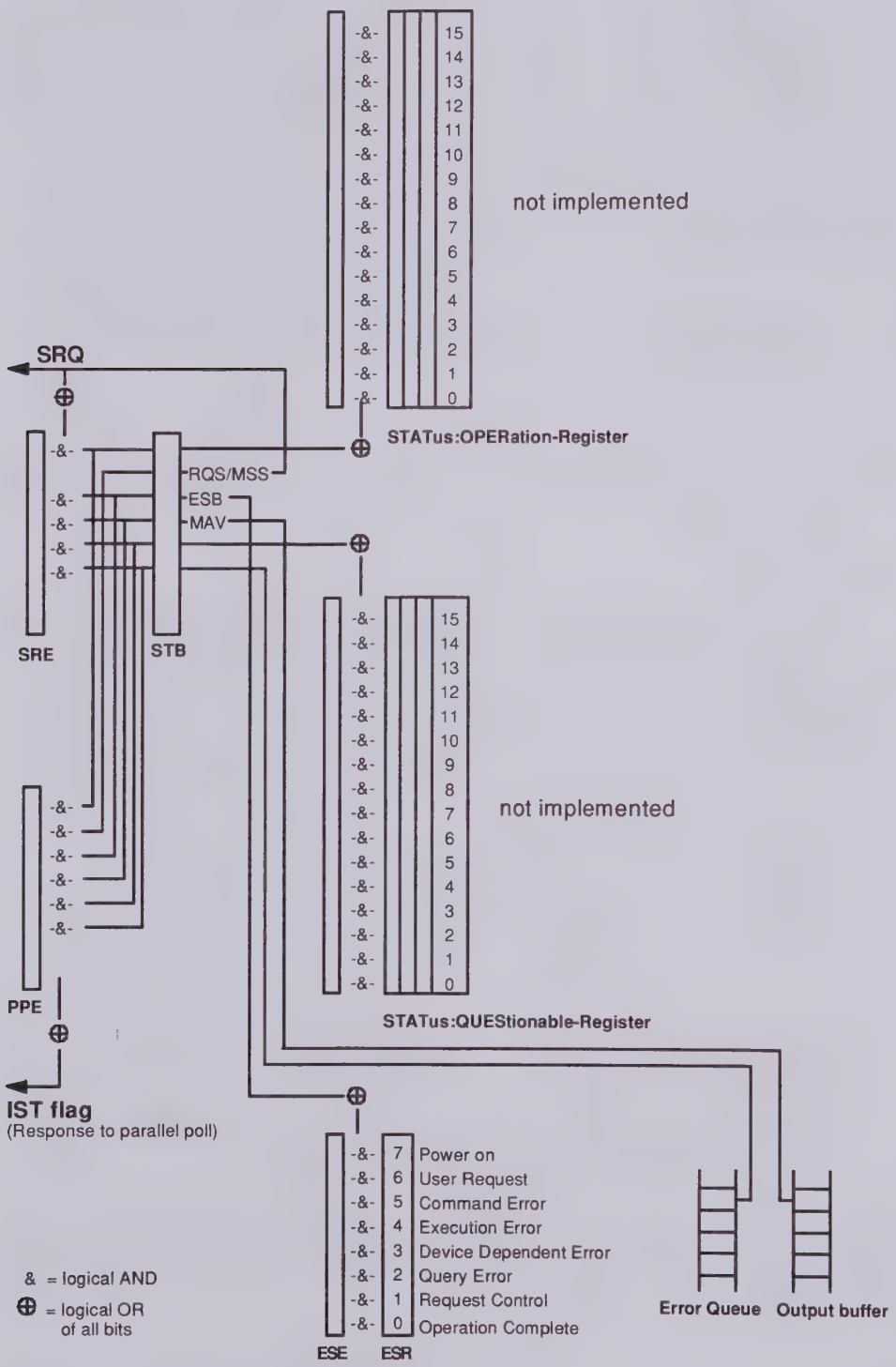


Fig. 5-4 Overview of status registers

Description of Status Registers

Status Byte (STB) and Service Request Enable Register (SRE)

The STB is already defined in IEEE 488.2. It provides a rough overview of the instrument status by collecting the pieces of information of the lower registers. It can thus be compared with the CONDition part of an SCPI register and assumes the highest level within the SCPI hierarchy. A special feature is that bit 6 acts as the sum bit of the remaining bits of the status byte.
The status byte is read using the command `*STB?` or a serial poll.

The STB is assigned an SRE. The SRE functionally corresponds to the ENABle part of the SCPI registers. Each bit of the STB is assigned a bit of the SRE. Bit 6 of the SRE is ignored. If a bit is set in the SRE and the associated bit in the STB changes from 0 to 1, a service request (SRQ) is generated on the IEC/IEEE bus which triggers an interrupt in the controller (if the controller is configured correspondingly) and can be further processed there.
The SRE can be set using the command `*SRE` and read using the command `*SRE?`.

Table 5-2 Meaning of the bits used in the status byte

Bit No.	Meaning
2	**Error Queue Not Empty** This bit is set if an entry is made in the error queue. If the bit is enabled by the SRE, each entry in the error queue generates a service request. Thus an error can be recognized and determined in greater detail by polling the error queue. The poll provides an informative error message. This procedure is recommended since it considerably reduces the problems involved in IEC/IEEE-bus control.
3	**QUEStionable Status sum bit** This bit is set if an EVENt bit is set in the QUEStionable status register and the associated ENABle bit is set to 1. If the bit is set, this indicates a questionable instrument status which can be determined in greater detail by polling the QUEStionable status register.
4	**MAV bit** (Message AVailable) This bit is set if a message is available in the output buffer which can be read. The bit can be used for the automatic reading of data from the instrument to the controller (see chapter 7, "Programming Examples").
5	**ESB bit** Sum bit of event status register. It is set if one of the bits of the event status register is set and enabled in the event status enable register. If the bit is set, this indicates a serious error which can be determined in greater detail by polling the event status register.
6	**MSS bit** (Master Status Summary bit) This bit is set if the instrument triggers a service request. This is the case if one of the other bits of this register is set together with its mask bit in the service request enable (SRE) register.
7	**OPERation Status Register sum bit** This bit is set if an EVENt bit is set in the OPERation status register and the associated ENABle bit is set to 1. If the bit is set, this indicates that the instrument is just carrying out an action. The type of action can be determined by polling the OPERation status register.

IST Flag and Parallel Poll Enable Register (PPE)

Analogously with the SRQ, the IST flag combines the entire status information in a single bit. It can be queried by means of a parallel poll (see section "Parallel Poll") or using the command `*IST?`.

The parallel poll enable (PPE) register determines which bits of the STB contribute to the IST flag. The bits of the STB are ANDed with the corresponding bits of the PPE. Unlike the SRE, bit 6 is used in this case. The IST flag results from the ORing of all results. The PPE can be set using the command `*PRE` and read using the command `*PRE?`.

Event Status Register (ESR) and Event Status Enable Register (ESE)

The ESR is already defined in IEEE 488.2. It can be compared with the EVENt part of an SCPI register. The event status register can be read using the command `*ESR?`.
The ESE is the associated ENABle part. It can be set using the command `*ESE` and read using the command `*ESE?`.

Table 5-3 Meaning of the bits used in the event status register

Bit No.	Meaning
0	**Operation Complete** This bit is set on receipt of the command `*OPC` when all previous commands have been executed.
2	**Query Error** This bit is set if either the controller wants to read data from the instrument without having sent a query, or if it does not fetch requested data and sends new instructions to the instrument instead. The cause is often a query which is errored and hence cannot be executed.
3	**Device-Dependent Error** This bit is set if a device-dependent error occurs. An error message with a number between -300 and -399 or a positive error number, which denotes the error in greater detail, is entered into the error queue (see Chapter 9, Section "Error Messages").
4	**Execution Error** This bit is set if a received command is syntactically correct but cannot be executed for other reasons. An error message with a number between -200 and –300, which denotes the error in greater detail, is entered into the error queue (see Chapter 9, Section "Error Messages").
5	**Command Error** This bit is set if a command is received which is undefined or syntactically not correct. An error message with a number between -100 and –200, which denotes the error in greater detail, is entered into the error queue (see Chapter 9, Section "Error Messages").
6	**User Request** This bit is set when the [LOCAL] key is pressed, ie when the instrument is switched over to manual control.
7	**Power On** (AC supply voltage On) This bit is set on switching on the instrument.

STATus:OPERation Register

Not impemented

STATus:QUEStionable Register

Not implemented

Use of Status Reporting System

To make effective use of the status reporting system, the information collected there must be transferred to the controller and further processed. There are several methods to this effect which are described in the following. For detailed examples see chapter 7, "Programming Examples").

Service Request, Making Use of Hierarchy Structure

Under certain conditions, the instrument can send a service request (SRQ) to the controller. The service request normally triggers an interrupt at the controller to which the control program can respond with corresponding actions. Fig. 5-4 shows that an SRQ is triggered if one or several of the bits 2, 3, 4, 5 and 7 of the status byte are set and enabled in the SRE. Each of these bits combines the information of another register, the error queue or the output buffer. By setting the ENABle parts of the status registers accordingly, it is achieved that arbitrary bits of an arbitrary status register trigger an SRQ. To make use of the possibilities of the service request, all bits of the SRE and ESE enable registers should be set to "1".

Examples (see also Fig. 5-4 and chapter 7, "Programming Examples"):

Use of command `*OPC` to generate an SRQ

- Set bit 0 in the ESE (Operation Complete).
- Set bit 5 in the SRE (ESB).

  The instrument generates an SRQ after completion of its settings.

Indication of end of sweep by means of an SRQ at the controller

- Set bit 7 (sum bit of STATus:OPERation register) in SRE.
- Set bit 3 (sweeping) in STATus:OPERation:ENABle.
- Set bit 3 in STATus:OPERation:NTRansition so that the transition of sweeping bit 3 from 1 to 0 (end of sweep) is recorded in the EVENt part.

  The instrument generates an SRQ after completion of a sweep.

The SRQ is the only way for the instrument to become active on its own. Each controller program should, therefore, set the instrument such that a service request is triggered in the event of a malfunction. The program should react appropriately to the service request. A detailed example of a service request routine is included in chapter 7, "Programming Examples".

Serial Poll

In a serial poll, just as with command `*STB`, the status byte of an instrument is queried. However, the query is implemented by means of interface messages and is therefore clearly faster. The serial-poll method has already been defined in IEEE 488.1 and used to be the only standard method for different instruments to query the status byte. The method also works with instruments which do not adhere to SCPI nor to IEEE 488.2.

The QuickBASIC command for executing a serial poll is `IBRSP()`. Serial polling is mainly used to obtain a fast overview of the states of several instruments connected to the IEC/IEEE bus.

Parallel Poll

In a parallel poll, up to eight instruments are simultaneously requested by the controller by means of a single command to transmit 1 bit of information each on the data lines, ie to set the data line allocated to each instrument to logically "0" or "1". Analogously to the SRE register, which determines under what conditions an SRQ is generated, there is a parallel poll enable (PPE) register, which is likewise ANDed with the STB bit by bit, with bit 6 being taken into account. The results are ORed, and the result of this is sent (possibly inverted) in response to a parallel poll by the controller. The result can also be queried without a parallel poll using the command `*IST`.

The instrument first has to be set for parallel polling by means of the QuickBASIC command `IBPPC()`. This command allocates a data line to the instrument and determines whether the response is to be inverted. The parallel poll itself is executed using `IBRPP()`.

The parallel-poll method is mainly used in order to find out quickly, after an SRQ, which instrument has sent the service request if there are many instruments connected to the IEC/IEEE bus. To this effect, the SRE and the PPE must be set to the same value. A detailed example on parallel polling will be found in chapter 7, "Programming Examples".

Query by Means of Commands

Each part of every status register can be read by means of a query. The queries to be used are included with the detailed description of the registers. In response to a query, a number is always returned which represents the bit pattern of the register queried. The number is evaluated by the controller program.

Queries are normally used after an SRQ to obtain more detailed information on the cause of the SRQ.

Error Queue Query

Each error state in the instrument leads to an entry in the error queue. The entries to the error queue are detailed plain-text error messages which can be displayed in the Error menu by manual control or queried via the IEC/IEEE bus with the command `SYSTem:ERRor?`. Each call of `SYSTem:ERRor?` provides one entry from the error queue. If no more error messages are stored there, the instrument responds with 0, ie "No error".

The error queue should be queried by the controller program after each SRQ as the entries provide a more precise description of the cause of an error than the status registers. Especially during the test phase of a controller program the error queue should be queried regularly since errored commands from the controller to the instrument are also recorded in the error queue.

Reset Values of Status Reporting System

Table 5-4 lists the commands and events that cause a reset of the status reporting system. Except for *RST and `SYSTem:PRESet`, none of the commands has an effect on the functional settings of the instrument. It should be noted in particular that DCL also does not change instrument settings.

Table 5-4 Resetting of instrument functions

Event	Switching on of AC supply voltage		DCL, SDC	*RST or SYSTem:PRESet	STATus:PRESet	*CLS
	Power On Status Clear		(Device Clear, Selected Device Clear)			
Effect	**0**	**1**				
Clears STB, ESR	—	yes	—	—	—	yes
Clears SRE, ESE	—	yes	—	—	—	—
Clears PPE	—	yes	—	—	—	—
Clears EVENt parts of the registers	—	yes	—	—	—	yes
Clears ENABle parts of all OPERation and QUESTionable registers, fills ENABle parts of all other registers with "1"	—	yes	—	—	yes	—
Fills PTRansition parts with "1", clears NTRansition parts	—	yes	—	—	yes	—
Clears error queue	yes	yes	—	—	—	yes
Clears output buffer	yes	yes	yes	1)	1)	1)
Clears command processing and input buffer	yes	yes	yes	—	—	—

1) Each command which is the first in a command line, ie which directly follows the <PROGRAM MESSAGE TERMINATOR>, clears the output buffer.

Interfaces

IEC/IEEE-Bus Interface

The instrument is equipped with an IEC/IEEE-bus interface as standard. The connector to IEEE 488 is provided at the rear of the instrument. A controller for remote control can be connected via the interface. Connection is made using a shielded cable.

Characteristics of Interface

- 8-bit parallel data transmission
- Bidirectional data transmission
- Three-wire handshake
- High data transmission rate, max. 350 kbyte/s
- Up to 15 devices can be connected
- Maximum length of connecting cables 15 m (single connection 2 m)
- Wired OR if several instruments are connected in parallel

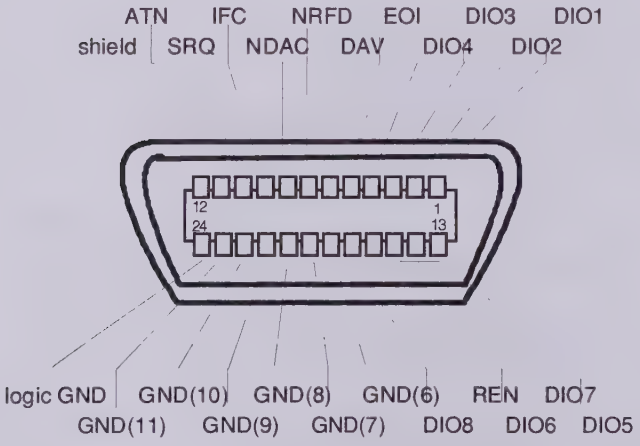


Fig. 5-5 Pin assignment of IEC/IEEE-bus interface

Bus Lines

1. Data bus with 8 lines DIO 1 to DIO 8

Transmission is bit-parallel and byte-serial in ASCII/ISO code. DIO1 is the least significant bit, DIO8 the most significant.

2. Control bus with 5 lines

IFC (Interface Clear):
Active LOW resets the interfaces of the instruments connected to the default setting.

ATN (Attention):
Active LOW signals the transmission of interface messages.
Inactive HIGH signals the transmission of device messages.

SRQ (Service Request):
Active LOW enables the instrument to send a service request to the controller.

REN (Remote Enable):
Active LOW enables switchover to remote control.

EOI (End or Identify):
This has two functions in conjunction with ATN:
ATN = HIGH Active LOW marks the end of a data transmission.
ATN = LOW Active LOW triggers a parallel poll.

3. Handshake bus with 3 lines

DAV (Data Valid):
Active LOW signals a valid data byte on the data bus.

NRFD (Not Ready For Data):
Active LOW signals that one of the devices connected is not ready to accept data.

NDAC (Not Data Accepted):
Active LOW as long as the instrument is accepting the data present on the data bus.

Interface Functions

Instruments which can be remote-controlled via the IEC/IEEE bus can be equipped with different interface functions. Table 5-5 lists the interface functions relevant for the instrument.

Table 5-5 Interface functions

Control character	Interface functions
SH1	Handshake source function (Source Handshake)
AH1	Handshake drain function (Acceptor Handshake)
L4	Listener function
T6	Talker function, ability to respond to serial poll
SR1	Service request function (Service Request)
PP1	Parallel poll function
RL1	Remote/local switchover function
DC1	Reset function (Device Clear)
DT1	Trigger function (Device Trigger)

Interface Messages

Interface messages are transmitted to the instrument on the data lines, with the ATN (Attention) line being active LOW. These messages serve for communication between the controller and the instrument.

Universal Commands

Universal commands are in the code range 10 to 1F hex. They act on all instruments connected to the bus without addressing them before.

Table 5-6 Universal commands

Command	QuickBASIC command	Effect on the instrument
DCL (Device Clear)	IBCMD (controller%, CHR$(20))	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
IFC (Interface Clear)	IBSIC (controller%)	Resets the interfaces to the default state.
LLO (Local Lockout)	IBCMD (controller%, CHR$(17))	Manual switchover to LOCAL is disabled.
SPE (Serial Poll Enable)	IBCMD (controller%, CHR$(24))	Ready for serial poll.
SPD (Serial Poll Disable)	IBCMD (controller%, CHR$(25))	End of serial poll.
PPU Parallel Poll Unconfigure)	IBCMD (controller%, CHR$(21))	End of parallel polling state.

Addressed Commands

Addressed commands are in the code range 00 to 0F hex. They only act on instruments addressed as listeners.

Table 5-7 Addressed commands

Command	QuickBASIC command	Effect on the instrument
SDC (Selected Device Clear)	IBCLR (device%)	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
GET (Group Execute Trigger)	IBTRG (device%)	Triggers a previously active instrument function (eg a sweep). The effect of this command is identical to that of a pulse at the external trigger signal input.
GTL (Go to Local)	IBLOC (device%)	Transition to LOCAL state (manual control).
PPC (Parallel Poll Configure)	IBPPC (device%, data%)	Configures the instrument for parallel polling. The QuickBASIC command additionally executes PPE / PPD.

RS-232-C Interface

The instrument is fitted with an RS-232-C interface as standard. The 9-contact interface is provided at the rear of the unit. A controller for remote control can be connected via the interface.

Characteristics of Interface

- Serial data transmission in asynchronous mode
- Bidirectional data transmission via two separate lines
- Selectable transmission rate from 120 to 15200 baud
- Logic 0 signal level from +3 V to +15 V
- Logic 1 signal level from –15 V to –3 V
- An external unit (controller) can be connected
- Software handshake (XON, XOFF)
- Hardware handshake

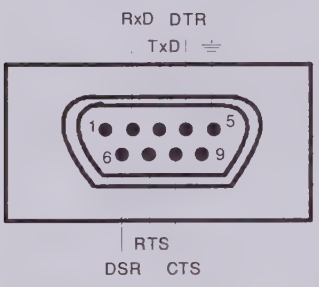


Fig. 5-6 Pin assignment of RS-232-C interface

Signal Lines

RxD (Receive Data):
Data line; transmission from external controller to instrument.

TxD (Transmit Data):
Data line; transmission from instrument to external controller.

DTR (Data terminal ready):
Output (logic zero = active). With DTR, the instrument indicates that it is ready to receive data. The DTR line controls the instrument's readiness for reception.

GND:
Interface ground, connected to instrument ground.

DSR (Data Set Ready):
(In the case of instruments with a VAR2 REV3 front module, the DSR line is used instead of the CTS line.)

RTS (Request To Send):
Output (logic 0 = active). With RTS, the instrument indicates that it is ready to receive data. The RTS line controls the instrument's readiness for reception.

CTS (Clear To Send):
Input (logic 0 = active). CTS informs the instrument that the opposite station is ready to receive data.

Transmission Parameters

To ensure error-free and correct data transmission, the transmission parameters on the instrument and the controller must have the same settings. The settings are made in the Utilities - System-RS232 menu.

Transmission rate (baud rate)
Eight different baud rates can be set on the instrument:
1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200

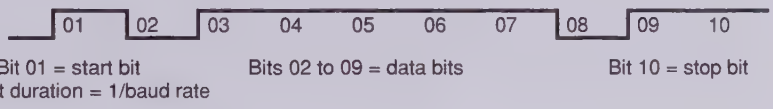
Data bits
Data transmission is in 8-bit ASCII code. The LSB (least significant bit) is transmitted as the first bit.

Start bit
The transmission of a data byte is initiated with a start bit. The falling edge of the start bit indicates the beginning of the data byte.

Parity bit
No parity bit is used.

Stop bit
The transmission of a data byte is terminated by a stop bit.

Example:
Transmission of character A (41 hex) in 8-bit ASCII code:



Interface Functions

For interface control, a number of control characters defined from 0 to 20 hex of the ASCII code can be transmitted via the interface.

Table 5-8 Control characters for RS-232-C interface

Control character	Function
<Ctrl Q> 11 hex	Enable character output (XON)
<Ctrl S> 13 hex	Stop character output (XOFF)
Break (at least 1 character logic 0)	Reset instrument
0Dhex, 0Ahex	Terminator <CR><LF> Local/remote switchover

Handshake

Software handshake

The software handshake with the XON/XOFF protocol controls data transmission.
If the receiver (instrument) wishes to inhibit the input of data, it sends XOFF to the transmitter. The transmitter then interrupts data output until it receives XON from the receiver. The same function is also provided at the transmitter end (controller).

Note: *The software handshake is not suitable for the transmission of binary data. Here the hardware handshake is to be preferred.*

Hardware handshake

With a hardware handshake, the instrument signals its readiness for reception via the lines DTR and RTS. A logic 0 means "ready", a logic 1 means "not ready".
Whether or not the controller is ready for reception is signalled to the instrument via the CTS or the DSR line (see section "Signal Lines"). The transmitter of the instrument is switched on by a logic 0 and off by a logic 1. The RTS line remains active as long as the serial interface is active. The DTR line controls the instrument's readiness for reception.

Wiring between instrument and controller

Wiring between the instrument and the controller is by means of a null modem, ie the data, control and signalling lines have to be cross-connected. The wiring plan below applies to controllers with a 9-pin or 25-pin connector.

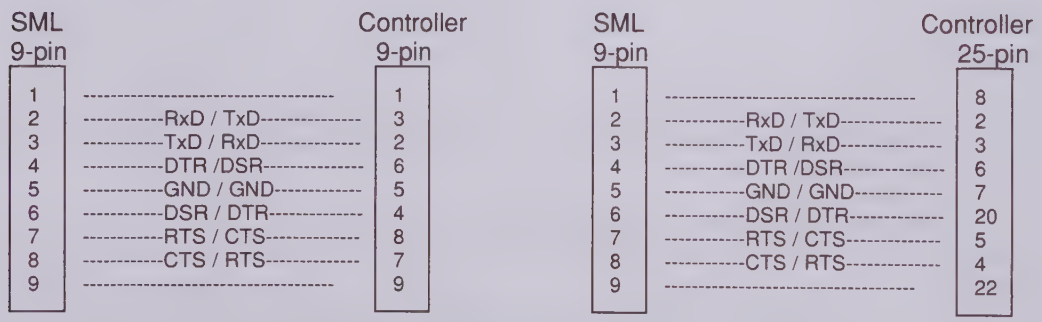


Fig. 5-7 Wiring of data, control and signalling lines for hardware handshake

6 Remote Control – Description of Commands

In the following sections, all commands implemented in the instrument are first listed in tables and then described in detail, separated according to the command system. The notation corresponds to the one of the SCPI standards to a large extent. The SCPI conformity information can be taken from the list of commands at the end of this chapter.
The description of manual operation, Chapter 4, indicates the corresponding IEC/IEEE-bus command for each manual setting.
A general introduction to remote control and a description of the status registers are to be found in Chapter 5. Detailed program examples of the main functions are to be found in Chapter 7.

Note: *In contrast to manual control, which is intended for maximum possible operating convenience, the priority of remote control is the predictability of the device status. This means that when incompatible settings are attempted, the command is ignored and the device status remains unchanged, i.e. is not adapted to other settings. Therefore, IEC/IEEE-bus control programs should always define an initial device status (e.g. with command *RST) and then implement the required settings.*

Notation

Table of Commands

Command: In the command column, the table provides an overview of the commands and their hierarchical arrangement (see indentations).

Parameter: In the parameter column the requested parameters are indicated together with their specified range.

Unit: The unit column indicates the basic unit of the physical parameters.

Remark: In the remark column an indication is made on
- whether the command does not have a query form,
- whether the command has only one query form,
- whether this command is implemented only with a certain option of the instrument.

Indentations

The different levels of the SCPI command hierarchy are represented in the table by means of indentations to the right. The lower the level is, the farther the indentation to the right is. Please observe that the complete notation of the command always includes the higher levels as well.

Example: `:SOURce:FM:MODE` is represented in the table as follows:

`:SOURce`	first level
`:FM`	second level
`:MODE`	third level

In the individual description, the complete notation of the command is given. An example for each command and - if it exists - the default value (*RST) is written out at the end of the individual description.

Upper/lower case notation

Upper/lower case letters serve to mark the long or short form of the key words of a command in the description. The instrument itself does not distinguish between upper and lower case letters.

Special characters |

A selection of key words with an identical effect exists for several commands. These key words are indicated in the same line, they are separated by a vertical stroke. Only one of these key words has to be indicated in the header of the command. The effect of the command is independent of which of the key words is indicated.

Example: `:SOURce`
`:FREQuency`
`:CW|:FIXed`

The two following commands of identical meaning can be formed. They set the frequency of the constantly frequent signal to 9 kHz:

```
:SOURce:FREQuency:CW 9E3 = SOURce:FREQuency:FIXed 9E3
```

A vertical stroke in indicating the parameters marks alternative possibilities in the sense of "or". The effect of the command is different, depending on which parameter is entered.

Example: Selection of the parameters for the command

```
SOURce:COUPling  AC | DC
```

If parameter AC is selected, only the AC content is fed through, in the case of DC, the DC as well as the AC content.

[ ] Key words in square brackets can be omitted when composing the header (cf. Chapter 5, Section "Optional Keywords"). The full command length must be accepted by the instrument for reasons of compatibility with the SCPI standards.
Parameters in square brackets can optionally be incorporated in the command or omitted as well.

{ } Parameters in braces can optionally be incorporated in the command either not at all, once or several times.

Common Commands

The common commands are taken from the IEEE 488.2 (IEC 625-2) standard. Same commands have the same effect on different devices. The headers of these commands consist of an asterisk "*" followed by three letters. Many common commands refer to the status reporting system which is described in detail in Chapter 5.

Table 6-1 Common Commands

Command	Parameter	Unit	Remark
*CLS			No query
*ESE	0 to 255		
*ESR?			Query only
*IDN?			Query only
*IST?			Query only
*OPC			
*OPC?			Query only
*OPT?			Query only
*PRE	0 to 255		
*PSC	0 | 1		
*RCL	1 to 50		No query
*RST			No query
*SAV	1 to 50		No query
*SRE	0 to 255		
*STB?			Query only
*TRG			No query
*WAI			

***CLS**

CLEAR STATUS sets the status byte (STB), the standard event register (ESR) and the EVENt-part of the QUEStionable and the OPERation register to zero. The command does not alter the mask and transition parts of the registers. It clears the output buffer.

***ESE** 0 to 255

EVENT STATUS ENABLE sets the event status enable register to the value indicated. Query *ESE? returns the contents of the event status enable register in decimal form.

***ESR?**

STANDARD EVENT STATUS QUERY returns the contents of the event status register in decimal form (0 to 255) and subsequently sets the register to zero.

***IDN?**

IDENTIFICATION QUERY queries the instrument identification.
The device response is for example: "Rohde&Schwarz,SML01,00000001,1.04"
01 = variant identification
00000001= serial number
1.04 = firmware version number

***IST?**

INDIVIDUAL STATUS QUERY returns the contents of the IST flag in decimal form (0 | 1). The IST flag is the status bit which is sent during a parallel poll.

***OPC**

OPERATION COMPLETE sets bit 0 in the event status register when all preceding commands have been executed. This bit can be used to initiate a service request.

***OPC?**

OPERATION COMPLETE QUERY returns 1, if all preceding commands have been executed. It is necessary to consider a sufficiently long time-out for the IEEE/IEC-bus.

***OPT?**

OPTION IDENTIFICATION QUERY queries the options included in the instrument and returns a list of the options installed. The options are separated from each other by means of commas. For every option, a fixed position is provided in the response.

Table 6-2 Device Response to *OPT?

Position	Option	
1	B1	Reference oscillator OXCO
2	reserved	
3	B3	Pulse modulation and pulse generator
4	reserved	
5	reserved	
6	reserved	
7	B19	Rear panel connectors

Example for a device response: B1, B3,0, 0,0,0,0,0,0, B19,0,0,0

***PRE** 0 to 255

PARALLEL POLL REGISTER ENABLE sets the parallel poll enable register to the value indicated. Query *PRE? returns the contents of the parallel poll enable register in decimal form.

***PSC** 0 | 1

POWER ON STATUS CLEAR determines whether the contents of the ENABle registers is maintained or reset in switching on.

*PSC = 0 causes the contents of the status registers to be maintained. Thus a service request can be triggered in switching on in the case of a corresponding configuration of status registers ESE and SRE.

*PSC ≠ 0 resets the registers.

Query *PSC? reads out the contents of the power-on-status-clear flag. The response can be 0 or 1.

***RCL** 1 to 50

RECALL calls the instrument state which was stored under the number supplied using command *SAV. 50 instrument states can be stored.

***RST**

RESET sets the instrument to a defined default status. The command essentially corresponds to pressing the [PRESET] key. The state of the RF-output is an exception: The RF-output is deactivated after *RST, however, it is activated after the [PRESET] key has been pressed. The default setting is indicated in the description of the commands.

***SAV** 1 to 50

SAVE stores the current instrument state under the number indicated (cf. *RCL as well).

***SRE** 0 to 255

SERVICE REQUEST ENABLE sets the service request enable register to the value indicated. Bit 6 (MSS mask bit) remains 0. This command determines under which conditions a service request is triggered. Query *SRE? reads the contents of the service request enable register in decimal form. Bit 6 is always 0.

***STB?**

READ STATUS BYTE QUERY reads out the contents of the status byte in decimal form.

***TRG**

TRIGGER triggers all actions waiting for a trigger event. Special trigger events can be started by command system "TRIGger" (see section "TRIGger System").

***WAI**

WAIT-to-CONTINUE only permits the servicing of the subsequent commands after all preceding commands have been executed and all signals have settled (cf. "*OPC" as well).

ABORt System

The ABORt system contains the commands to abort actions triggered. After an action has been aborted, it can be triggered again at once. All commands trigger an event, thus they have no *RST value.

Further commands for the trigger system of the SML can be found in the TRIGger system.

Command	Parameter	Default Unit	Remark
:ABORt [:SWEep]			No query

:ABORt[:SWEep]

The command restarts a sweep.

Example: `:ABOR:SWE`

CALibration System

The CALibration System contains the commands for external calibrations. For calibration of Ref Osc see Service Manual.

Command	Parameter	Default Unit	Remark
:CALibration			
:LEVel			
:STATe	ON | OFF		
:ATTenuator			
:STATe	ON | OFF		
:LPReset			
[:MEASure]?			
:LFGenlevel			
[:MEASure]?			
:HARMfilter			
[:MEASure]?			
:MULTfilter			
[:MEASure]?			
:IFFilter			
[:MEASure]?			
:MAINloop			
[:MEASure]?			
:FMOFfset			
[:MEASure]?			
:VMODulation			
[:MEASure]?			
[:SOURce]			
:POWer			
:ALC			
:TABLe			
[:MEASure]?			
:ROSCillator			
[:DATA]?			
:STORe			

:CALibration:LEVel:STATe

The command switches level correction ON or OFF.

Example: `:CAL:LEV:STAT ON` *RST value is ON

:CALibration:ATTenuator:STATe

The command switches ON or OFF the correction values of the attenuator.

Example: `:CAL:ATT:STAT ON` *RST value is ON

:CALibration:LPReset[:MEASure]?

The command calibrates Level Preset. "0" is returned for O.K. and "1" in case of an error.

Example: `:CAL:LPR?`

:CALibration:LFGenlevel[:MEASure]?

The command calibrates the level of the LF generator. "0" is returned for O.K. and "1" in case of an error.

Example: `:CAL:LFG?`

:CALibration:HARMfilter[:MEASure]?

The command calibrates the Harmonic Filters. "0" is returned for O.K. and "1" in case of an error.

Example: `:CAL:HARM?`

:CALibration:MULTfilter[:MEASure]?

The command calibrates the Multiplier Filters. "0" is returned for O.K. and "1" in case of an error.

Example: `:CAL:MULT?`

:CALibration:IFFilter[:MEASure]?

The command calibrates the IF Filters. "0" is returned for O.K. and "1" in case of an error.

Example: `:CAL:IFF?`

:CALibration:MAINloop[:MEASure]?

The command calibrates the Mainloop. "0" is returned for O.K. and "1" in case of an error.

Example: `:CAL:MAIN?`

:CALibration:FMOFfset[:MEASure]?

The command calibrates the FM offset. "0" is returned for O.K. and "1" in case of an error.

Example: `:CAL:FMOF?`

:CALibration:VMODulation[:MEASure]?

The command triggers a calibration for the I/Q modulator in the whole Rf frequency range. "0" is returned for O.K. and "1" in case of an error.

Example: `:SOUR:POW:ALC:TABL?:CAL:VMOD?`

******:SOURce:POWer:ALC:TABLe[:MEASure]?**

The command regenerates correction values for the ALC Table function. "0" is returned for O.K. and "1" in case of an error.

Example: `:SOUR:POW:ALC:TABL?`

:CALibration[:ALL]?

The command executes automatically all calibrations in the indicated order. "0" is returned for O.K. and "1" in case of an error.

Example: `:CAL?`

:CALibration:ROSCillator[:DATA]?

The command displays the calibration value entered in the Utilities - Calib - RefOsc menu.

Example: `:CAL:ROSC?`

:CALibration:ROSCillator:STORe

The command stores the calibration value entered in the Utilities - Calib - RefOsc menu.

Example: `:CAL:ROSC:STOR`

DIAGnostic System

The DIAGnostic system contains the commands for diagnostic test and service of the instrument. SCPI does not define DIAGnostic commands, the commands listed here are SML-specific. All DIAGnostic commands are queries which are not influenced by *RST. Hence no default setting values are stated.

Command	Parameter	Default Unit	Remark
:DIAGnostic			
:INFO			
:CCOunt			
:POWer?			Query only
:MODules?			Query only
:OTIMe?			Query only
:SDATe?			Query only
[:MEASure]			
:POINt?			Query only

:DIAGnostic:INFO

The commands which can be used to query all information which does not require hardware measurement are under this node.

:DIAGnostic:INFO:CCOunt:POWer?

The command queries the number of switch-on processes.

Example: `:DIAG:INFO:CCO:POW?` Response: 258

:DIAGnostic:INFO:MODules?

The command queries the modules existing in the instrument with their model and state-of-modification numbers. The response supplied is a list in which the different entries are separated by commas. The length of the list is variable and depends on the equipment of the instrument. Each entry consists of three parts which are separated by means of blanks:

1. Name of module
2. Variant of module in the form VarXX (XX = 2 digits)
3. Revision of module in the form RevXX (XX = 2 digits)

Example `:DIAG:INFO:MOD?` Response: `ROSC VAR01 REV00`

:DIAGnostic:INFO:OTIMe?

The command reads out the internal operating-time counter. The response supplies the number of hours the instrument has been in operation.

Example: `:DIAG:INFO:OTIM?` Response: `19`

:DIAGnostic:INFO:SDATe?

The command queries the date of software creation. The response is returned in the form year, month, day.

Example: `:DIAG:INFO:SDAT?` Response: `1999, 12, 19`

:DIAGnostic:[:MEASure]

The commands which trigger a measurement in the instrument and return the measured value are under this node.

:DIAGnostic[:MEASure]:POINt?

The command triggers a measurement at a measuring point and returns the voltage measured. The measuring point is specified by a numeric suffix (cf. service manual).

Example: `:DIAG:MEAS:POIN? 2` Response: `11.56`

DISPLAY System

This system contains the commands to configure the screen. If system security is activated using command `SYSTem:SECurity ON`, the display cannot be switched on and off arbitrarily (cf. below).

Command	Parameter	Default Unit	Remark
:DISPlay			
:ANNotation			
[:ALL]	ON | OFF		
:AMPLitude	ON | OFF		
:FREQuency	ON | OFF		

:DISPlay:ANNotation

The commands determining whether frequency and amplitude are indicated are under this node.

Caution: *With SYSTem:SECurity ON, the indications cannot be switched from OFF to ON. In this case *RST does not influence the ANNotation settings either. With SYSTem:SECurity OFF, the *RST value is ON for all ANNotation parameters.*

:DISPlay:ANNotation[:ALL] ON | OFF

The command switches the frequency and amplitude indication on or off.

Command `:DISP:ANN:ALL ON` can only be executed if `SYST:SEC` is set to `OFF`.

Example: `:DISP:ANN:ALL ON` With `SYST:SEC OFF` - *RST value is ON

:DISPlay:ANNotation:AMPLitude ON | OFF

The command switches on or off the amplitude indication.

Command `:DISP:ANN:AMPL ON` can only be executed if `SYST:SEC` is set to `OFF`.

Example: `:DISP:ANN:AMPL ON` With `SYST:SEC OFF` - *RST value is ON

:DISPlay:ANNotation:FREQuency ON | OFF

The command switches on or off the frequency indication.

Command `:DISP:ANN:FREQ ON` can only be executed if `SYST:SEC` is set to `OFF`.

Example: `:DISP:ANN:FREQ ON` With `SYST:SEC OFF` - *RST value is ON

MEMory System

This system contains the commands for the memory management of the SML.

Command	Parameter	Default Unit	Remark
:MEMory :NSTates?			Query only

:MEMory:NSTates?

The command returns the number of *SAV/*RCL memories available. The SML has 50 *SAV/*RCL memories in total.

Example: `:MEM:NST?` Response: `50`

OUTPut System

This system contains the commands specifying the characteristics of the RF, LF and Pulse output sockets. The following numbers are assigned to these outputs:

OUTPut1: RF output,

OUTPut2: LF output,

OUTPut3: PULSE/VIDEO output.

Command	Parameter	Default Unit	Remark
:OUTPut1|2|3			
:AMODe	AUTO | FIXed		
:POLarity			
:PULSe	NORMal | INVerted		
:SOURce	OFF | PULSegen | VIDeo		
[:STATe]	OFF | ON		
:PON	OFF | UNCHanged		
:VOLTage	0 V to 4 V	V	

:OUTPut1:AMODe AUTO | FIXed

The command switches over the operating mode of the attenuator (Attenuator MODe) at the RF output (output1).

AUTO The attenuator is switched whenever possible.

FIXed The attenuator is switched when certain fixed levels are exceeded/not reached.

Example: `:OUTP:AMOD AUTO` *RST value is AUTO

:OUTPut3:POLarity:PULSe NORMal | INVerted

The command determines the polarity of the signal at the PULSE/VIDEO output.

Example: `:OUTP3:POL:PULS INV` *RST value is NORM

:OUTPut3:SOURce OFF | PULSegen | VIDeo

The command selects between pulse generator and video output.

Example: `:OUTP3:SOUR VID` *RST value is OFF

:OUTPut1|2[:STATe] ON | OFF

The command switches on or off the RF output (output1) or the LF output (output2). The RF output can also be switched off by the response of the protective circuit. But this has no influence on this parameter.

Note: *In contrast to the PRESET key, command *RST sets the value for output1 to OFF, the RF-output is deactivated.*

Example: `:OUTP:STAT ON` *RST value is OFF

:OUTPut1[:STATe]:PON OFF | UNCHanged

This command selects the state the RF output (output1) is to assume after power-on of the unit. It only exists for the RF output. *RST does not influence the set value.

OFF Output is switched off

UNCHanged Same state as before switch-off

Example: `:OUTP:PON OFF`

:OUTPut2:VOLTage 0 V to 4 V

The command sets the voltage of the LF-output (output2). The voltage is a characteristic of the output, not of the source. I.e., the voltage is maintained even if another generator is connected to the output.

Example: `:OUTP2:VOLT 3.0V` *RST value is 1 V

SOURce System

This system contains the commands to configure the RF signal source. Keyword SOURce is optional, i.e., it can be omitted. The LF signal source is configured in the SOURce2 system.

The following subsystems are realized in the instrument:

Subsystem	Settings
[:SOURce]	
:AM	Amplitude modulation
:CORRection	Correction of the output level
:FM	Frequency modulation
:FREQuency	Frequencies including sweep
:PHASe	Phase of the output signal
:PM	Phase modulation
:POWer	Output level, level control and level correction
:PULM	Pulse modulation
:PULSe	Pulse generator
:ROSCillator	Reference oscillator
:STEReo	Stereo modulation
:SWEep	Sweeps

SOURce:AM Subsystem

This subsystem contains the commands to control the amplitude modulation. An LF generator which serves as internal modulation source is fitted in the instrument. Part of the settings is effected under SOURce2.

Command	Parameters	Default Unit	Remark
[:SOURce]			
:AM			
[:DEPTh]	0 to100 PCT	PCT	
:EXTernal			
:COUPling	AC | DC		
:INTernal			
:FREQuency	0. 1 Hz to 1 MHz	Hz	
:SOURce	EXTernal | INTernal | TTONe		
:STATe	ON | OFF		

[:SOURce]:AM[:DEPTh] 0 to 100 PCT

The command sets the modulation depth in percent. *RST value is 30PCT

Example: `:SOUR:AM:DEPT 15PCT`

[:SOURce]:AM:EXTernal

The commands to set the external AM input are under this node.

[:SOURce]:AM:EXTernal:COUPling AC | DC

The command selects the type of coupling for the external AM input.

AC The d.c. voltage content is separated from the modulation signal.

DC The modulation signal is not altered. *RST value is AC

Example: `:SOUR:AM:EXT:COUP AC`

[:SOURce]:AM:INTernal

The settings for the internal AM input are effected under this node.

Here the same hardware is set for AM, FM/ΦM and SOURce2. This means that, for example, the following commands are coupled to each other and have the same effect:

```
SOUR:AM:INT:FREQ
SOUR:FM:INT:FREQ
SOUR:PM:INT:FREQ
SOUR2:FREQ:CW
```

[:SOURce]:AM:INTernal:FREQuency 0.1Hz to 1 MHz

The command sets the modulation frequency.

Example: `:SOUR:AM:INT:FREQ 15kHz` *RST value is 1 kHz

[:SOURce]:AM:SOURce EXTernal | INTernal | TTONe

The command selects the modulation source. An external and an internal modulation source can be specified at the same time.

Example: `:SOUR:AM:SOUR EXT,INT` *RST value is INT

[:SOURce]:AM:STATe OFF | ON

The command switches amplitude modulation on or off.

Example: `:SOUR:AM:STAT ON` *RST value is OFF

SOURce:CORRection Subsystem

The CORRection subsystem permits a correction of the output level. The correction is effected by adding user-defined table values to the output level as a function of the RF frequency. In the SML, this subsystem serves to select, transmit and switch on User-Correction tables (see Section "User Correction (Ucor)" as well).

Command	Parameters	Default Unit	Remark
[:SOURce]			
:CORRection			
[:STATe]	ON | OFF		
:CSET			
:CATalog?			query only
:FREE?			query only
[:SELect]	"name of table "		
:DATA			
:FREQuency	9 kHz to 3.3 GHz {9 kHz to 3.3 GHz}	Hz	
:POWer	+20 to -20 dB {,+20 to -20 dB }	dB	
:POINts?			query only
:DELete	"name of table "		
:ALL			

[:SOURce]:CORRection[:STATe] ON | OFF

The command switches the table selected using `SOUR:CORR:CSET` on or off.

Example: `:SOUR:CORR:STAT ON` *RST value is OFF

[:SOURce]:CORRection:CSET

The commands to select and edit the Ucor tables are under this node.

[:SOURce]:CORRection:CSET:CATalog?

The command requests a list of Ucor tables. The individual lists are separated by means of commas. This command is a query and has no *RST value.

Example: `:SOUR:CORR:CAT?` Answer: `"UCOR1", "UCOR2", "UCOR3"`

[:SOURce]:CORRection:CSET:FREE?

This command queries the free space in the Ucor table.

The command is a query and thus has no *RST value.

Example: `:SOUR:CORR:FREE?`

[:SOURce]:CORRection:CSET[:SELect] "name of table"

The command selects a Ucor table. This command alone does not yet effect a correction. First the table selected must be activated (cf. `:SOUR:CORR:STAT`). If there is no table of this name, a new table is created. The name may contain up to 7 letters. This command triggers an event and hence has no *RST value.

Example: `:SOUR:CORR:CSET:SEL "UCOR1"`

[:SOURce]:CORRection:CSET:DATA

The commands to edit the Ucor tables are under this node.

[:SOURce]:CORRection:CSET:DATA:FREQuency 9 kHz to 3.3 GHz {,9 kHz to 3.3 GHz}, 3.3 GHz depends on model

The command transmits the frequency data for the table selected using `:SOUR:CORR:CSET`. The frequency values must be entered in ascending order. *RST does not influence data lists.

Example: `:SOUR:CORR:CSET:DATA:FREQ 100MHz,102MHz,103MHz,...`

[:SOURce]:CORRection:CSET:DATA:POWer +20 to -20dB {,+20 to -20dB }

The command transmits the level data for the table selected using `:SOUR:CORR:CSET`. *RST does not influence data lists.

Example: `:SOUR:CORR:CSET:DATA:POWer 1dB, 0.8dB, 0.75dB,...`

[:SOURce]:CORRection:CSET:DATA:POWer:POINts?

The command returns the number of list elements.

This command is a query and hence has no *RST value.

Example: `:SOUR:CORR:CSET:DATA:POW:POIN?`

[:SOURce]:CORRection:CSET:DELete "name of table"

The command deletes the table indicated from the instrument memory. This command triggers an event and hence has no *RST value.

Example: `:SOUR:CORR:CSET:DEL "UCOR3"`

SOURce:FM Subsystem

This subsystem contains the commands to control the frequency modulation and to set the parameters of the modulation signal.

Command	Parameters	Default Unit	Remark
[:SOURce]			
:FM			
[:DEViation]	0 kHz to 20/40 MHz	Hz	
:EXTernal			
:COUPling	AC | DC		
:INTernal			
:FREQuency	0.1 Hz to 1 MHz	Hz	
:SOURce	EXTernal | INTernal | DOUBle		
:STATe	ON | OFF		
:BANDwidth	STANdard | WIDE		

[:SOURce]:FM [:DEViation] 0 kHz to 20/40 MHz

The command specifies the frequency variation caused by the FM. The maximum possible deviation depends on the selected frequency (see Data Sheet).

Example: `:SOUR:FM:DEV 5kHz` *RST value is 10 kHz

[:SOURce]:FM:EXTernal

The commands to set the external FM input are under this node. The settings under EXTernal for modulations AM and FM are independent of each other.

[:SOURce]:FM:EXTernal:COUPling AC | DC

The command selects the type of coupling for the external FM input.

AC The d.c. voltage content is separated from the modulation signal.

DC The modulation signal is not altered.

Example: `:SOUR:FM:EXT:COUP AC` *RST value is AC

[:SOURce]:FM:INTernal

The settings for the internal LF generator are effected under this node. Here the same hardware is set for AM, FM/ΦM and SOURce2.

This means that, e.g., the following commands are coupled to each other and have the same effect:

```
:SOUR:AM:INT:FREQ
:SOUR:FM:INT:FREQ
:SOUR:PM:INT:FREQ
:SOUR2:FREQ:CW
```

[:SOURce]:FM:INTernal:FREQuency 0.1 Hz to 1 MHz

The command sets the modulation frequency.

Example: `:SOUR:FM:INT:FREQ 10kHz` *RST value is 1 kHz

[:SOURce]:FM:SOURce EXTernal | INTernal | TTONe

The command selects the modulation source. An external and an internal modulation source can be specified at the same time (cf. example).

Example: `:SOUR:FM:SOUR INT, EXT` *RST value is INT

[:SOURce]:FM:STATe ON | OFF

The command switches the frequency modulation on or off.

Example: `SOUR:FM:STAT OFF` *RST value is OFF

[:SOURce]:FM:BANDwidth STANdard | WIDE

The command sets the bandwidth for FM. STANdard and WIDE are available.

Example: `SOUR:FM:BAND WIDE` *RST value is STAN

SOURce:FREQuency Subsystem

This subsystem contains the commands for the frequency settings of the RF source including the sweeps.

Command	Parameters	Default Unit	Remark
[:SOURce]			
:FREQuency			
:CENTer	9 kHz to 3.3 GHz	Hz	3.3 GHz
[:CW | :FIXed]	9 kHz to 3.3 GHz	Hz	3.3 GHz
:RCL	INCLude | EXCLude		
:MANual	9 kHz to 3.3 GHz	Hz	3.3 GHz
:MODE	CW | FIXed | SWEep		
:OFFSet	-50 to +50 GHz	Hz	
:SPAN	0 to 3.3 GHz - 9 kHz	Hz	3.3 GHz
:STARt	9 kHz to 3.3 GHz	Hz	3.3 GHz
:STOP	9 kHz to 3.3 GHz	Hz	3.3 GHz
:STEP			
[:INCRement]	0 to 3 GHz	Hz	
:ERange	ON | OFF		

[:SOURce]:FREQuency:CENTer 9 kHz to 3.3 GHz (3.3 GHz)

The command sets the sweep range by means of the center frequency. This command is coupled to the commands `[:SOUR]:FREQ:STAR` and `[:SOUR]:FREQ:STOP`.

Here the Offset-value is taken into account.

Example: `:SOUR:FREQ:CENT 300MHz` *RST value is (STARt +STOP)/2

[:SOURce]:FREQuency[:CW | :FIXed] 9 kHz to 3 GHz (3 GHz)

The command sets the frequency for CW operation. This value is coupled to the current sweep frequency. In addition to a numeric value, UP and DOWN can be indicated. The frequency is increased or reduced by the value set under `[:SOUR]:FREQ:STEP` (as to specify range, see `FREQ:CENT`).

Example: `:SOUR:FREQ 500MHz` *RST value is 100 MHz

[:SOURce]:FREQuency:RCL INCLude | EXCLude

The command determines the effect of the recall function on the frequency. *RST value has no effect to this setting.

INCLude The saved frequency is loaded when instrument settings are loaded with the [RCL] key or with a memory sequence.

EXCLude The RF frequency is not loaded when instrument settings are loaded, the current settings are maintained.

Example: `:SOUR:FREQ:RCL INCL`

[:SOURce]:FREQuency:MANual 9 kHz to 3.3 GHz (3.3 GHz)

The command sets the frequency if `SWE:MODE MAN` and `:FREQ:MODE SWE` are set. Only frequency values between the settings with `[:SOUR]:FREQ:STAR` and `...:STOP` are permitted. (As to the permitted range, cf. `FREQ:CENT`).

Example: `:SOUR:FREQ:MAN 500MHz` *RST value is 100 MHz

[:SOURce]:FREQuency:MODE CW | FIXed | SWEep

The command specifies the operating mode and hence also specifies which commands control the FREQuency subsystem. The parameters are assigned as follows:

CW | FIXed CW and FIXed are synonyms. The output frequency is specified by means of `[:SOUR]:FREQ:CW | FIX`.

SWEep The instrument operates in the SWEep-mode. The frequency is specified by means of commands `[:SOUR]:FREQ:STAR; STOP; CENT; SPAN; MAN`.

Example: `:SOUR:FREQ:MODE SWE` *RST value is CW

[:SOURce]:FREQuency:OFFSet -50 to +50 GHz

The command sets the frequency offset of a mixer which might be series-connected (cf. Chapter 4, Section "Frequency Offset").

Example: `:SOUR:FREQ:OFFS 100MHz` *RST value is 0

[:SOURce]:FREQuency:SPAN 0 to 3.3 GHz - 9 kHz (3.3 GHz)

This command specifies the frequency range for the sweep. This parameter is coupled to the start and stop frequency. Negative values for SPAN are permitted, then STARt > STOP is true. The following relations hold:

STARt = CENTer - SPAN/2

STOP = CENTer + SPAN/2

Example: `:SOUR:FREQ:SPAN 400MHz` *RST value is (STOP - STARt)

[:SOURce]:FREQuency:STARt 9 kHz to 3.3 GHz (3.3 GHz depends on model)

This command defines the starting value of the frequency for the sweep operation. Parameters STARt, STOP, SPAN and CENT are coupled to each other. STARt may be larger than STOP. (As to specified range, cf. `FREQ:CENT`).

Example: `:SOUR:FREQ:STAR 500MHz` *RST value is 100 MHz

[:SOURce]:FREQuency:STOP 9 kHz to 3.3 GHz (3.3 GHzl)

This command indicates the final value of the frequency for the sweep operation (see STARt as well). (As to the specified range, cf. `FREQ:CENT`).

Example: `:SOUR:FREQ:STOP 1GHz` *RST value is 500 MHz

[:SOURce]:FREQuency:STEP

The command to enter the step width for the frequency setting if frequency values UP or DOWN are used is under this node. This command is coupled to the Knob Step command in manual control. Only linear step widths can be set.

[:SOURce]:FREQuency:STEP[:INCRement] 0 to 3 GHz

The command sets the step width for the frequency setting.

Example: `:SOUR:FREQ:STEP:INCR 1MHz` *RST value is 1 MHz

[:SOURce]:FREQuency:ERANge ON | OFF

The command activates or deactivates the Extended Divider Range function.

Example: `:SOUR:FREQ:ERAN ON` *RST value is OFF

SOURce:PHASe Subsystem

This subsystem contains the commands to adjust phase between the RF output signal and a reference signal of the same frequency.

Command	Parameters	Default Unit	Remark
[:SOURce]			
:PHASe	-380 to 360 DEG | UP | DOWN	DEG	
:STEP	-360 to 360 DEG	DEG	
:REFerence			
:STATe	ON | OFF		

[:SOURce]:PHASe -360 to 360 DEG | UP | DOWN

Setting value of the phase of the output signal with respect to a reference signal of the same frequency. Phase values from -360 ° to 360 ° are possible. Alternatively, the actual setting value can be varied by UP or DOWN steps. The command [:SOURCE]:PHASe:STEP specifies the step width. Step widths from -360 ° to 360 ° are possible.

Example: `:SOUR:PHAS 40 DEG` *RST value is 0 DEG

[:SOURce]:PHASe:STEP -360 to 360 DEG

The command sets the step width for [:SOURce]:PHASe UP or [:SOURce]:PHASe DOWN. Step widths from -360 ° to 360 ° are possible. Preset or *RST does not change the step width.

Example: `:SOUR:PHAS:STEP 90 DEG`

[:SOURce]:PHASe:REFerence

The command sets the phase value to 0. The phase of output signal will not be changed.

Example: `:SOUR:PHAS:REF` *RST value is 0

[:SOURce]:PHASe:STATe ON | OFF

Switching on/off phase setting.

Example: `:SOUR:PHAS:STAT ON` *RST value is OFF

SOURce:PM Subsystem

This subsystem contains the commands to control the phase modulation and to set the parameters of the modulation signal.

Command	Parameter	Default Unit	Remark
[:SOURce]			
:PM			
[:DEViation]	0 to 10	RAD	
:EXTernal			
:COUPling	AC | DC		
:INTernal			
:FREQuency	0.1 Hz to 10 MHz	Hz	
:SOURce	EXTernal | INTernal | TTONe		
:STATe	ON | OFF		
:BANDwidth	STANdard | WIDE		

[:SOURce]:PM [:DEViation] 0 to 10 RAD

The command specifies the phase variation caused by the ΦM. The maximum possible deviation depends on the selected frequency (see Data Sheet).

Example: `:SOUR:PM:DEV 2 RAD` *RST value is 1 RAD

[:SOURce]:PM:EXTernal

The commands to set the external ΦM input are under this node. The settings under EXTernal for modulations AM, FM and ΦM are independent of each other.

[:SOURce]:PM:EXTernal:COUPling AC | DC

The command selects the type of coupling for the external ΦM input.

AC The d.c. voltage content is separated from the modulation signal.

DC The modulation signal is not altered.

Example: `:SOUR:PM:EXT:COUP AC` *RST value is AC

[:SOURce]:PM:INTernal

The settings for the internal LF generator are effected under this node. Here the same hardware is set for AM, FM/ΦM and SOURce2.

This means that, e.g., the following commands are coupled to each other and have the same effect:

```
:SOUR:AM:INT:FREQ
:SOUR:FM:INT:FREQ
:SOUR:PM:INT:FREQ
:SOUR2:FREQ:CW
```

[:SOURce]:PM:INTernal:FREQuency 0.1 Hz to 10 MHz

The command sets the modulation frequency.

Example: `:SOUR:PM:INT:FREQ 10kHz` *RST value is 1 kHz

[:SOURce]:PM:SOURce EXTernal | INTernal | TTONe

The command selects the modulation source. An external and an internal modulation source can be specified at the same time (cf. example).

Example: `:SOUR:PM:SOUR INT, EXT` *RST value is INT

[:SOURce]:PM:STATe ON | OFF

The command switches the phase modulation on or off.

Example: `SOUR:PM:STAT OFF` *RST value is OFF

[:SOURce]:PM:BANDwidth STANdard | WIDE

The command sets the bandwidth for ΦM. STANdard and WIDE are available.

Example: `SOUR:PM:BAND WIDE` *RST value is STAN

SOURce:POWer Subsystem

This subsystem contains the commands to set the output level, the level control and the level correction of the RF signal. Other units can be used instead of dBm:

- by indication directly after the numeric value (example `:POW 0.5V`).

Command	Parameters	Default Unit	Remark
[:SOURce]			
:POWer			
:ALC			
:SEARch?			Query only
[:STATe]	ON | OFF		
[:LEVel]			
[:IMMediate]			
[AMPLitude]	-130 dBm to +25 dBm	dBm	
:OFFSet	-100 to +100 dB	dB	
:LIMit			
[:AMPLitude]	-130 dBm to +25 dBm	dBm	
:MANual	-130 dBm to +25 dBm	dBm	
:MODE	CW | FIXed | SWEep		
:RCL	INCLude | EXCLude		
:STARt	-130 dBm to +25 dBm	dBm	
:STOP	-130 dBm to +25 dBm	dBm	
:STEP			
[:INCRement]	0.1 to 10 dB	dB	

[:SOURce]:POWer:ALC

The commands checking the automatic level control are under this node.

[:SOURce]:POWer:ALC:SEArch?

This command defines under which conditions the control loop is temporarily closed. The command is suitable only if `SOUR:POW:ALC:STAT` is set to `OFF`. This command is a query and hence has no *RST value.

Example: `:SOUR:POW:ALC:SEAR?`

[:SOURce]:POWer:ALC[:STATe] ON | OFF

The command switches the level control on or off.

ON Level control is permanently switched on.

OFF Level control is switched on for a short period of time if the level changes.

Example: `:SOUR:POW:ALC:STAT ON` *RST value is ON

[:SOURce]:POWer[:LEVel][:IMMediate]

The commands to set the output levels for the CW- and SWEEP modes are under this node.

[:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude] -130 dBm to +25 dBm

The command sets the RF output level in operating mode CW. UP and DOWN can be indicated in addition to numeric values. Then the level is increased or reduced by the value indicated under `[:SOUR]:POW:STEP`.

In this command, the OFFSet value is considered. Thus the specified range indicated is only valid for `:SOUR:POW:OFFS 0`.

The keywords of this command are optional to a large extent, thus the long as well as the short form of the command is shown in the example.

Example: `:SOUR:POW:LEV:IMM:AMPL -10` or
`:POW -10` *RST value is -30 dBm or -20 dBm

[:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude]:OFFSet -100 to +100 dB

The command enters the constant level offset of a series-connected attenuator/ amplifier (cf. Chapter 4, Section "Level Offset"). If a level offset is entered, the level entered using `:POW` does no longer conform to the RF output level. The following relation is true:

`:POW` = RF output level + `:POW:OFFS`

Entering a level offset does not change the RF output level but only the value queried by `:POW`. The level offset is also valid for level sweep!

Only dB is permissible as a unit here, linear units (V, W etc.) are not permitted.

Example: `:SOUR:POW:LEV:IMM:AMPL:OFFS 0` or
`:POW:OFFS 0` *RST value is 0 dB

[:SOURce]:POWer:LIMit[:AMPLitude] -130 dBm to +25 dBm

The command limits the maximum RF output level in operating mode CW and SWEEP. It does not influence the display LEVEL and the answer to query `POW?`.

Example: `:SOUR:POW:LIM:AMPL 19` *RST value is +16 dBm

[:SOURce]:POWer:MANual -130 dBm to +25 dBm

The command sets the level if `SOUR:POW:MODE` is set to `:SWE` and `SOUR:SWE:MODE` to `MAN`. Only level values between STARt and STOP are permitted (as to specified range, cf. `:POW:AMPL`).

Example: `:SOUR:POW:MAN 1dBm` *RST value is -30 dBm or -20 dBm

[:SOURce]:POWer:MODE CW | FIXed | SWEep

The command specifies the operating mode and thus also by means of which commands the level setting is checked.

CW | FIXed The output level is specified by means of commands under `[:SOUR]:POW:LEV`.

SWEep The instrument operates in the SWEep mode. The level is specified by means of `[:SOUR]:POW; STAR; STOP; CENT; SPAN` and `MAN`.

Example: `:SOUR:POW:MODE FIX` *RST value is FIX

[:SOURce]:POWer:RCL INCLude | EXCLude

INCLude The stored RF level is loaded too when instrument settings are loaded.

EXCLude The stored RF level is not loaded when instrument settings are loaded ie the current level setting is maintained.

Example: `:SOUR:POW:RCL INCL` *RST value is EXCL

[:SOURce]:POWer:STARt -130 dBm to +25 dBm

The command sets the staring value for a level sweep. STARt may be larger than STOP, then the sweep runs from the high to the low level (As to specified range, cf. `:POW)`.

Example: `:SOUR:POW:STAR -20` *RST value is -30 dBm or -20 dBm

[:SOURce]:POWer:STOP -130 dBm to +25 dBm

The command sets the final value for a level sweep. STOP may be smaller than STARt. (As to specified range, cf. `:POW`).

Example: `:SOUR:POW:STOP 3` *RST value is -10dBm

[:SOURce]:POWer:STEP[:INCRement] 0.1 to 10 dB

The command sets the step width with the level setting if UP and DOWN are used as level values. The command is coupled to Knob Step in the manual control, i.e., it also specifies the step width of the shaft encoder.

Only dB is permissible as a unit here, the linear units (V, W etc.) are not permitted.

Example: `:SOUR:POW:STEP:INCR 2` *RST value is 1dB

SOURce:PULM Subsystem

This subsystem contains the commands to control the pulse modulation (Option SML-B3) and to set the parameters of the modulation signal. The internal pulse generator is set in the :SOURce:PULSe subsystem.

Command	Parameters	Default Unit	Remark
[:SOURce]			
:PULM			Option SML-B3
:EXTernal			
:POLarity	NORMal | INVerse		
:SOURce	INTernal | EXTernal		
:STATe	ON | OFF		

[:SOURce]:PULM:EXTernal

The commands to control the input socket for the external pulse generator are under this node.

[:SOURce]:PULM:POLarity NORMal | INVerse

The command specifies the polarity between modulating and modulated signal.

NORMal The RF signal is suppressed during the interpulse period.

INVerse The RF signal is suppressed during the pulse.

Example: :SOUR:PULM:POL INV *RST value is NORM

[:SOURce]:PULM:SOURce EXTernal | INTernal

The command selects the source of the modulating signal.

INTernal Internal pulse generator.

EXTernal Signal fed externally.

Example: :SOUR:PULM:SOUR INT *RST value is INT

[:SOURce]:PULM:STATe ON | OFF

The command switches on or off the pulse modulation.

Example: :SOUR:PULM:STAT ON *RST value is OFF

SOURce:PULSe Subsystem

This subsystem contains the commands to set the pulse generator (Option SML-B3). The pulse generation is triggered on principle, with the trigger certainly being able to be set to "free run" using `TRIG:PULS:SOUR AUTO` as well.

Command	Parameters	Default Unit	Remark
[:SOURce]			
:PULSe			Option SML-B3
:DELay	20 ns to 1.3 s	s	
:DOUBle			
:DELay	60 ns to 1.3 s	s	
[:STATe]	ON | OFF		
:PERiod	100 ns to 85 s	s	
:WIDTh	20 ns to 1.3 s	s	

[:SOURce]:PULSe:DELay 20 ns to 1.3 s

The command specifies the time from the start of the period to the first edge of the pulse. Due to the construction of the instrument, this parameter is set to 0 if `[:SOUR]:PULS:DOUB:STAT` is set to `ON`. The old value is activated again as soon as the double pulse has been switched off.

Example: `:SOUR:PULS:DEL 10us` *RST value is 1 µs

[:SOURce]:PULSe:DOUBle

The commands to check the second pulse are under this node. If `[:SOUR]:PULS:DOUB:STAT` is set to `ON`, a second pulse whose width is identical to the first pulse is generated in every period.

[:SOURce]:PULSe:DOUBle:DELay 60 ns to 1.3 s

The command sets the delay time from the start of the pulse period to the first edge of the second pulse.

Example: `:SOUR:PULS:DOUB:DEL 10us` *RST value is 1 µs

[:SOURce]:PULSe:DOUBle[:STATe] ON | OFF

The command switches the second pulse on or off.

ON The second pulse is switched on.

Parameter `[:SOUR]:PULS:DEL` is set to 0 and cannot be changed. WIDTh > (`PULS:PER - PULS:DOUB:DEL`)/2 results in error message -221, "Settings conflict".

OFF The second pulse is switched off.

Example: `:SOUR:PULS:DOUB:STAT OFF` *RST value is OFF

[:SOURce]:PULSe:PERiod 100 ns to 85 s

The command sets the pulse period.

The pulse period is the reciprocal value of the pulse frequency, thus this command is coupled to command `[:SOUR]:PULM:INT:FREQ`.

Example: `:SOUR:PULS:PER 2s` *RST value is 10 µs

[:SOURce]:PULSe:WIDTh 20 ns to 1.3 s

The command sets the pulse width.

Example: `:SOUR:PULS:WIDT 0.1s` *RST value is 1 µs

SOURce:ROSCillator Subsystem

This subsystem contains the commands to set the external and internal reference oscillator.

Command	Parameters	Default Unit	Remark
[:SOURce]			
:ROSCillator			
[:INTernal]			
:ADJust			
[:STATe]	ON | OFF		
:VALue	0 to +4095		
:SOURce	INTernal | EXTernal		

[:SOURce]:ROSCillator[:INTernal]

The commands to set the internal reference oscillator are under this node.

[:SOURce]:ROSCillator[:INTernal]:ADJust

The commands for frequency adjustment (fine-tuning of the frequency) are under this node.

[:SOURce]:ROSCillator[:INTernal]:ADJust[:STATe] ON | OFF

The command switches the frequency adjustment on or off.

Example: `:SOUR:ROSC:INT:ADJ:STAT ON` *RST value is OFF

[:SOURce]:ROSCillator[:INTernal]:ADJust:VALue 0 to +4095

The command indicates the frequency correction value (tuning value). For a detailed definition, cf. Section "Reference Frequency Internal/External".

Example: `:SOUR:ROSC:INT:ADJ:VAL 0` *RST value is 0

[:SOURce]:ROSCillator[:INTernal]:RLOop NORMal | NARRow

The command sets the bandwidth of the reference loop. Normal and Narrow are available.

Example: `:SOUR:ROSC:INT:RLO NORM` *RST value is NORM

[:SOURce]:ROSCillator:SOURce INTernal | EXTernal

The command selects the reference source.

INTernal The internal oscillator is used.

EXTernal The reference signal is fed externally.

Example: `:SOUR:ROSC:SOUR EXT` *RST value is INT

SOURce:STEReoSubsystem

This subsystem contains the commands to control the stereo modulation, the ARI functions and basic RDS functions. and to set the parameters of the modulation signal. All RDS functions of the Stereo/RDS coder can be set by means of

[SOURce]:STEReo:DIRect: "string"

Queries are formed as follows:

[SOURce]:STEReo:DIRect? ["string"]

Command	Parameters	Default Unit	Remark
[:SOURce]			
:STEReo			
:ARI			
:BK			
[:CODE]	A | BI | C | D | E | F		
[:DEViation]	0 to 10 kHz	Hz	
:STATe	ON | OFF		
:TYPE	DK | BK | BKDK		
:STATe	ON | OFF		
:AUDio			
[:FREQency]	0,1 Hz to 1MHz	Hz	
:MODE	LEFT | RIGHt | RELeft | REMLeft| RNELeft		
:PREemphasis	50 us | 75 us	s	
:STATe	ON | OFF		
:EXTernal			
:IMPedance	600 Ohm | kOhm	Ohm	
[:DEViation]	0 to 80 kHz	Hz	
:DIRect	String		
:PILot			
[:DEViation]	0 to 10 kHz	Hz	
:PHAse	-5 to 5 DEG	DEG	
:STATe	ON | OFF		
:RDS			
:DATaset	DS1 | DS2 | DS3 | DS4 | DS5		
[:DEViation]	0 to 10 kHz	Hz	
:STATe	ON | OFF		
:TRAFfic			
:PROGram	ON | OFF		
[:STATe]			
:ANNouncement	**[:STATe]** ON | OFF		
	LREXt | SPEXt | LFGen		
:SOURce	ON | OFF		
:STATe			

[:SOURce]:STEReo:ARI

The commands to set the ARI functions are under this node.

[:SOURce]:StEReo:ARI:BK[:CODE] A | BI | C | D | E | F

The command selects the standard traffic area codes A to F.

Example: `:SOUR:STER:ARI BK F` *RST value A

[:SOURce]:STEReo:ARI[:DEViation] 0 to 10 kHz

Input value of the frequency deviation of the ARI subcarrier.

Example: `:SOUR:STER:ARI 4 kHz` *RST value is 3.5 kHz

[:SOURce]:STEReo:ARI:STATe ON | OFF

Switching on/off ARI subcarrier.

Example: `:SOUR:STER:ARI:STAT ON` *RST value is OFF

[:SOURce]:STEReo:TYPE: DK | BK | BKDK

Selection of ARI broadcasting code (DK) and ARI area code (BK).

DK	Broadcasting code is selected
BK	Area code is selected
BKDK	Broadcasting code and area code are selected

Example: `:SOUR:STER:TYPE:BKDK` *RST value is DK

[:SOURce]:STEReo:ARI:TYPE:STATe ON | OFF

Switching on/off ARI area code and braodcasting code.

Example: `:SOUR:STER:ARI:STAT ON` *RST value is OFF

[:SOURce]:STEReo:AUDio

The commands to set the frequency of LF generator, the operating mode (L, R, L=R, L=-R, L≠R) and the prempasis are under this node. Unter diesem Knoten befinden sich die

[:SOURce]:STEReo:AUDio:MODE LEFT | RIGHt | RELeft | REMLeft| RNELeft

Selection of the operating mode

LEFT	Audio signal only in the left-hand channel
RIGHt	Audio signal only in the right-hand channel
RELeft	Audio signals of same frequency and phase in both channels.
REMLeft	Audio signals of same frequency but opposite phase in both channels
RNELeft	Different and independent audio signals in both channels (not possible with internal LG generator).

Example: `:SOUR:STER:AUD:MODE REL` *RST value is RELeft

[:SOURce]:STEReo:AUDio[:FREQency] 0.1 Hz to 1 MHz

Input value of the frequency of the LF generator.

Example: `:SOUR:STER:AUD 3 kHz` *RST value is 1 kHz

[:SOURce]:STEReo:AUDio:PREemphasis 50 us | 75 us

Selection of the preemphasis.

Example: `:SOUR:STER:AUD:PRE 75 us` *RST value is 50 us

[:SOURce]:STEReo:AUDio:PREemphasis:STATe ON | OFF

Switching on/of preemphasis.

Example: `:SOUR:STER:AUD:PRE:STAT ON` *RST value is OFF

[:SOURce]:STEReo:EXTernal:IMPedance 600 Ohm | 100 kOhm

Selection of the input impedances of the analog audio inputs I and R. Both input impedances are switched simultaneously

Example: `:SOUR:STER:EXT:IMP 600 Ohm` *RST value is 100 kOhm

[:SOURce]:STEReo[:DEViation] 0 to 80 kHz

Setting value the frequency deviation of the stereo signal.

Example: `:SOUR:STER 50 kHz` *RST value is 40 kHz

[:SOURce]:STEReo:DIRect String

Command to send the RDS setting strings to the RDS /Stereo coder.

Example: `:SOUR:STER:DIR to`

[:SOURce]:STEReo:PILot

Commands for pilot tone settings are under this node.

[:SOURce]:STEReo:PILot[:DEViation] 0 to 10 kHz

Setting value of the frequency deviation of the pilot tone.

Example: `:SOUR:STER:PIL 5 kHz` *RST value is 6.75 kHz

[:SOURce]:STEReo:PILot:PHAse -5 to 5 DEG

Setting value of phase of the pilot tone.

Example: `:SOUR:STER:PIL:PHA 3 DEG` *RST value is 0 DEG

[:SOURce]:STEReo:PILot:STATe ON | OFF

Switching on/off the pilot tone.

Example: `:SOUR:STER:PIL:STAT ON` *RST value is OFF

[:SOURce]:STEReo:RDS

Commands to the basis RDS functions which can also be operated manually are under this node.

[:SOURce]:STEReo:RDS:DATaset DS1 | DS2 | DS3 | DS4 | DS5

Selection and activation of the RDS data sets DS1 to DS 5.

Example: `:SOUR:STER:RDS:DAT DS5` *RST value is DS1

[:SOURce]:STEReo:RDS[:DEViation] 0 to 10 KHz

Setting value of the frequency deviation of the RDS subcarrier.

Example: `:SOUR:STER:RDS 5 kHz` *RST value is 2 kHz

[:SOURce]:STEReo:RDS:STATe ON | OFF

Switching on/off RDS function.

Example: `:SOUR:STER:RDS:STAT ON` *RST value is OFF

[:SOURce]:STEReo:RDS:TRAFfic:PROGram:STATe ON | OFF

Switchung on/ofF traffic program.

Example: `:SOUR:STER:RDS:TRAF:PROG:STAT ON` *RST value is OFF

[:SOURce]:STEReo:RDS:TRAFfic:ANNouncement[:STATe] ON | OFF

Switching on/off traffic announcement.

Example: `:SOUR:STER:RDS:TRAF:ANN ON` *RST value is OFF

[:SOURce]:STEReo:SOURce LREXt | SPEXt | LFGen

Selection of the modulation sources for stereo modulation (the modulation sources cannot be used simultaneously).

LREXt Activates the L and R inputs for external analog modulation signals.

SPEXt Activates the S/P DIF input for the external digital modulation signal.

LFGen The modulation signal is generated by the internal LF generator.

Example: `:SOUR:STER:SOUR LFGEN` *RST value is LREXt

[:SOURce]:STEReo:STATe ON | OFF

Switching on/off stereo modulation.

Example: `:SOUR:STER:STAT ON` *RST value is OFF

SOURce:SWEep Subsystem

This subsystem contains the commands to control the RF sweep, i.e., sweeps of the RF generators. Sweeps are triggered on principle. The frequency sweep is activated by command `SOUR:FREQ:MODE SWE`, the level sweep by command `SOUR:POW:MODE SWE`.

Command	Parameters	Default Unit	Remark
[:SOURce]			
:SWEep			
[:FREQuency]			
:DWELl	10 ms to 5 s	s	
:MODE	AUTO | MANual | STEP		
:SPACing	LINear | LOGarithmic		
:STEP			
[:LINear]	0 to 1 GHz / 0 to 2 GHz / 0 to 3 GHz	Hz	SML
:LOGarithmic	0.01 to 100 PCT	PCT	
:POWer			
:DWELl	10 ms to 5 s	s	
:MODE	AUTO | MANual | STEP		
:SPACing	LOGarithmic		
:STEP	0 to 160 dB	dB	
[:LOGarithmic]	MAXimum | MINimum		

[:SOURce]:SWEep[:FREQuency]

The commands to set the frequency sweeps are under this node. Keyword `[:FREQuency]` can be omitted (cf. examples). The commands are SCPI compatible then unless stated otherwise.

[:SOURce]:SWEep[:FREQuency]:DWELl 10 ms to 5 s

The command sets the dwell time per frequency step.

Example: `:SOUR:SWE:DWEL 12ms` *RST value is 15 ms

[:SOURce]:SWEep[:FREQuency]:MODE AUTO | MANual | STEP

The command specifies the run of the sweep.

AUTO Each trigger triggers exactly one entire sweep cycle.

MANual Each frequency step of the sweep is triggered by means of manual control or a `SOUR:FREQ:MAN` command, the trigger system is not active. The frequency increases or decreases (depending on the direction of the shaft encoder) by the value indicated under `[:SOUR]:FREQ:STEP:INCR`.

STEP Each trigger triggers only one sweep step (single-step mode). The frequency increases by the value indicated under `[:SOUR]:SWE:STEP:LOG`.

Example: `:SOUR:SWE:MODE AUTO` *RST value is AUTO

[:SOURce]:SWEep[:FREQuency]:SPACing LINear | LOGarithmic

The command selects whether the steps have linear or logarithmic spacings.

Example: `:SOUR:SWE:SPAC LIN` *RST value is LIN

[:SOURce]:SWEep[:FREQuency]:STEP

The commands to set the step width for linear and logarithmic sweeps are under this node. The settings of `:STEP:LIN` and `:STEP:LOG` are independent of each other.

[:SOURce]:SWEep[:FREQuency]:STEP[:LINear] 0 to 1 GHz/0 to 2 GHz /0 to 3 GHz (SML)

The command sets the step width with the linear sweep. If `:STEP[:LIN]` is changed, the value of POINts valid for `:SPAC:LIN` also changes according to the formula stated under POINts. A change of SPAN does not result in a change of `:STEP[:LIN]`. Keyword `[:LIN]` can be omitted, then the command conforms to SCPI regulations (see example).

Example: `:SOUR:SWE:STEP 1MHz` *RST value is 1 MHz

[:SOURce]:SWEep[:FREQuency]:STEP:LOGarithmic 0.01 to 100 PCT

The command indicates the step width factor for logarithmic sweeps. The next frequency value of a sweep is calculated according to

new frequency = previous frequency + `STEP:LOG` x previous frequency (if STARt < STOP)

`:STEP:LOG` indicates the fraction of the previous frequency by which this is increased for the next sweep step. Usually `:STEP:LOG` is indicated in percent, with the suffix PCT having to be used explicitly. If `:STEP:LOG` is changed, the value of POINts valid for `:SPAC:LOG` also changes according to the formula stated under POINts. A change of STARt or STOP does not result in a change of `:STEP:LOG`.

Example: `:SOUR:SWE:STEP:LOG 10PCT` *RST value is 1 PCT

[:SOURce]:SWEep:POWer

The commands to set the power sweeps are under this node.

[:SOURce]:SWEep:POWer:DWELl 10 ms to 5 s

The command sets the dwell time per level step.

Example: `:SOUR:SWE:POW:DWEL 12ms` *RST value is 15 ms

[:SOURce]:SWEep:POWer:MODE AUTO | MANual | STEP

The command specifies the sweep mode.

AUTO Each trigger triggers exactly one entire sweep cycle.

MANual Each level step of the sweep is triggered by means of manual control or a `SOUR:POW:MAN` command, the trigger system is not active. The level increases or decreases (depending on the direction of the shaft encoder) by the value stated under `[:SOUR]:POW:STEP:INCR`.

STEP Each trigger triggers only one sweep step (single-step mode). The level increases by the value indicated under `[:SOUR]:POW:STEP:INCR`.

Example: `:SOUR:SWE:POW:MODE AUTO` *RST value is AUTO

[:SOURce]:SWEep:POWer:SPACing LOGarithmic

The command defines that the sweep steps have logarithmic spacings. It permits the query of SPACing.

Example: `:SOUR:SWE:POW:SPAC LOG` *RST value is LOG

[:SOURce]:SWEep:POWer:STEP

The commands to set the step width for the sweep are under this node.

[:SOURce]:SWEep:POWer:STEP[:LOGarithmic] 0 to 160 dB

The command indicates the step width factor for logarithmic sweeps. The next level value of a sweep is calculated according to

new level = previous level + STEP:LOG × previous level

`STEP:LOG` denotes the fraction of the previous level by which this is increased for the next sweep step. Usually `:STEP:LOG` is entered in units of dB, with suffix dB having to be specified explicitly. If `:STEP:LOG` is changed, the value of POINts also changes according to the formula indicated under POINts. A change of STARt or STOP does not result in a change of `:STEP:LOG`. Keyword `:LOG` can be omitted, then the command conforms to SCPI regulation (see example).

Example: `:SOUR:SWE:POW:STEP 10dB` *RST value is 1dB

SOURce2 System

The SOURce2 system contains the commands to configure the LF signal source. The LF signal source s designated as INT if it is used as a modulation source, if it is used as an LF generator, it is designated as SOURce2.

The commands to set the output voltage of the LF generator are in the OUTPut2 system.

Subsystems	Settings
:SOURce2	
:FREQuency	Frequency with CW and sweep operation
:SWEep	LF sweep

SOURce2:FREQuency Subsystem

This subsystem contains the commands for the frequency settings including the sweeps.

Command	Parameters	Default Unit	Remark
:SOURce2			
:FREQuency			
[:CW|:FIXed]	0.1 Hz to 1 MHz	Hz	
:MANual	0.1 Hz to 1 MHz	Hz	
:MODE	CW | FIXed | SWEep		
:STARt	0.1 Hz to 1 MHz	Hz	
:STOP	0.1 Hz to 1 MHz	Hz	

:SOURce2:FREQuency[:CW | :FIXed] 0.1 Hz to 1 MHz

The command sets the frequency for the CW mode.

Example: `:SOUR2:FREQ:CW 1kHz` RST value is 1 kHz

:SOURce2:FREQuency:MANual 0.1 Hz to 1 MHz

The command sets the frequency if `SOUR2:SWE:MODE MAN` and `SOUR2:FREQ:MODE SWE` are set. In this case, only frequency values between the settings `:SOUR2:FREQ:STAR` and to `:STOP` are allowed.

Example: `:SOUR2:FREQ:MAN 1kHz` *RST value is 1 kHz

:SOURce2:FREQuency:MODE CW | FIXed | SWEep

The command specifies the operating mode and hence by means of which commands the FREQuency subsystem is controlled. The following allocations are valid:

CW | FIXed CW and FIXed are synonyms. The output frequency is specified by means of `SOUR2:FREQ:CW | FIX`.

SWEep The generator operates in the SWEep mode. The frequency is specified by means of commands `:SOUR2:FREQ:STAR; STOP; MAN`.

Example: `:SOUR2:FREQ:MODE CW` *RST value is CW

:SOURce2:FREQuency:STARt 0.1 Hz to 1 MHz

This command defines the starting value of the frequency for the sweep.

Example: `:SOUR2:FREQ:STAR 1kHz` *RST value is 1 kHz

:SOURce2:FREQuency:STOP 0.1 Hz to 1 MHz

This command defines the end value of the frequency for the sweep.

Example: `:SOUR2:FREQ:STOP 200kHz` *RST value is 100 kHz

SOURce2:SWEep Subsystem

This subsystem contains the commands to control the LF sweep of SOURce2. LF-Sweeps are activated by command `SOUR2:MODE SWE`. Sweeps are triggered on principle.

Command	Parameters	Default Unit	Remark
:SOURce2			
:SWEep			
[:FREQuency]			
:DWELl	10 ms to 5 s	s	
:MODE	AUTO | MANual | STEP		
:SPACing	LINear | LOGarithmic		
:STEP			
[:LINear]	0 to 10MHz	Hz	
:LOGarithmic	0.01 PCT to 100 PCT	PCT	

:SOURce2:SWEep[:FREQuency]

The commands to set the frequency sweeps are under this node. Keyword [:FREQuency] can be omitted. Then the commands are SCPI-compatible unless stated otherwise (see examples).

:SOURce2:SWEep[:FREQuency]:DWELl 10 ms to 5 s

The command sets the time per frequency step (dwell).

Example: `:SOUR2:SWE:DWEL 20ms` *RST value is 15 ms

:SOURce2:SWEep[:FREQuency]:MODE AUTO | MANual | STEP

The command specifies the run of the sweep.

AUTO Each trigger triggers exactly one entire sweep cycle.

STEP Each trigger triggers only one sweep step (single-step mode). The frequency increases by the value defined under `:SOUR2:SWE:STEP`.

Example: `:SOUR2:SWE:MODE AUTO` *RST value is AUTO

:SOURce2:SWEep[:FREQuency]:SPACing LINear | LOGarithmic

The command selects whether the steps have linear or logarithmic spacings.

Example: `:SOUR2:SWE:SPAC LOG` *RST value is LIN

:SOURce2:SWEep[:FREQuency]:STEP

The commands to set the step width with linear and logarithmic sweeps are under this node. The settings of `STEP:LIN` and `STEP:LOG` are independent of each other.

:SOURce2:SWEep[:FREQuency]:STEP[:LINear] 0 to 1 MHz

The command sets the step width with the linear sweep. If `STEP:LIN` is changed, the value of POINts valid for `SPAC:LIN` also changes according to the formula defined under POINts. A change of SPAN does not cause a change of `STEP:LIN`. Keyword `[:LIN]` can be omitted, then the command conforms to SCPI regulation (see example).

Example: `:SOUR2:SWE:STEP 10kHz` *RST value is 1 kHz

:SOURce2:SWEep[:FREQuency]:STEP:LOGarithmic 0.01 to 100PCT

This command defines the step width factor for logarithmic sweeps. The next frequency value of a sweep is calculated as follows (if STARt < STOP) :

New frequency = previous frequency + STEP:LOG x previous frequency

`STEP:LOG` , therefore, indicates the fraction of the previous frequency by which that frequency is increased for the next sweep step. `STEP:LOG` is usually indicated in percent, with the suffix PCT having to be used explicitly. If `STEP:LOG` is changed, the value of POINts valid for `SPACing:LOGarithmic` also changes according to the formula stated under POINts. A change of STARt or STOP does not result in a change of `STEP:LOGarithmic`.

Example: `:SOUR2:SWE:STEP:LOG 5PCT` *RST value is 1 PCT

STATus System

This system contains the commands for the status reporting system (c.f. Section "Status Reporting System"). STATus:OPERation register and STATus:QUEStionable register are not implemented. *RST has no influence on the status registers.

Command	Parameters	Default Unit	Remark
:STATus			
:PRESet			No query
:QUEue			
[:NEXT]?			Query only

:STATus:PRESet

The command resets the edge detectors and ENABle parts of all registers to a defined value. All PTRansition parts are set to FFFFh, i.e., all transitions from 0 to 1 are detected. All NTRansition parts are set to 0, i.e., a transition from 1 to 0 in a CONDition bit is not detected.

Example: `:STAT:PRES`

:STATus:QUEue [:NEXT]?

The command queries the entry that has been in the error queue for the longest time and thus deletes it. Positive error numbers denote errors specific of the instrument, negative error numbers error messages specified by SCPI (see Chapter 5). If the error queue is empty, 0, "No error", is returned. The command is identical to `SYST:ERR?`

Example: `STAT:QUE:NEXT?` Answer: `221, "Settings conflict"`

SYSTem System

In this system, a number of commands for general functions which are not immediately related to signal generation, are combined.

Command	Parameters	Default Unit	Remark
:SYSTem			
:COMMunicate			
:GPIB			
[:SELF]			
:ADDRess	1 to 30		
:SERial			
:BAUD	1200 | 2400 | 4800 | 9600 | 19200 | 38400 | 57600 | 115200		
:BITS	7 | 8		
:SBITs	1 | 2		
:CONTrol			
:RTS	ON | IBFull | RFR		
:PACE	XON | NONE		
:PARity	ODD | EVEN | NONE		
:DISPlay			
:UPDate			
[:STATe]	ON | OFF		
:ERRor?			Query only
:PRESet			No query
:PROTect[1|2|3|4]			
[:STATe]	ON | OFF, password		
:SECurity			
[:STATe]	ON | OFF		
:SERRor?			Query only
:VERSion?			Query only

:SYSTem:COMMunicate

The commands to set the remote control interfaces are under this node.

:SYSTem:COMMunicate:GPIB

The commands to control the IEC bus are under this node (GPIB = General Purpose Interface Bus).

:SYSTem:COMMunicate:GPIB[:SELF]:ADDRess 1 to 30

The command sets the IEC bus instrument address. *RST value is 28

Example: `:SYST:COMM:GPIB:ADDR 1`

:SYSTem:COMMunicate:SERial

The command to set the serial interface are under this node. The data format is fixedly set to 8 data bits, no parity and 1 stop bit. These values cannot be changed. The device represents a DTE (Data Terminal Equipment) in relation to the serial interface. Therefore the the controller must be connected via a 0-modem.

:SYSTem:COMMunicate:SERial:BAUD 1200| 2400| 4800| 9600| 19200| 38400| 57600| 115200

The commands sets the baud rate for both the transmit and the receive direction. *RST has no influence on this parameter.

Example: `:SYST:COMM:SER:BAUD 1200` *RST value is 9600

:SYSTem:COMMunicate:SERial:BITS 7 | 8

The command sets the length of a data word.

Example: `:SYST:COMM:SER:BITS` *RSTvalue is 7

:SYSTem:COMMunicate:SERial:SBITs 1 | 2

The command defines whether 1 or 2 stop bits are used.

Example: `:SYST:COMM:SER:SBIT` *RST value is 1

:SYSTem:COMMunicate:SERial:CONTrol:RTS ON | IBFull | RFR

The commands sets the hardware handshake. *RST has no influence on this parameter.

ON Interface line RTS is always active.

IBFull | RFR Input Buffer Full | Ready For Receiving.
Interface line RTS remains active as long as the instrument is ready to receive data.

Example: `:SYST:COMM:SER:CONT:RTS ON` *RST value is RFR

:SYSTem:COMMunicate:SERial:PACE XON | NONE

The command sets the software handshake. *RST has no influnence on this parameter.

XON Software handshake using the ASCII codes 11h (XON) and 13h (XOFF).

Note: *This mode is not recommended for binary data and for baud rates above 9600 bauds.*

NONE No software handshake.

Example: `:SYST:COMM:SER:PACE NONE` *RST value is NONE

:SYSTem:COMMunicate:SERial:PARity ODD | EVEN | NONE

The command defines the parity test.

Example: `:SYST:COMM:SER:PAR ODD` *RST value is EVEN

:SYSTem:DISPlay:UPDate[:STATe] ON | OFF

ON The header line of the display indicates frequency and level values.

OFF The header line of the display remains empty.

This function is only available via IEC/IEEE-bus.

Example: `:SYST:DISP:UPD OFF` *RST value is ON

:SYSTem:ERRor?

The command queries the entry that has been in the error queue for the longest time. Positive error numbers denote errors specific of the instrument, negative error numbers denote error messages specified by SCPI (see Chapter 9). If the error queue is empty, 0, "No error", is returned. The command is identical to `STAT:QUE:NEXT?`

Example: `:SYST:ERR?` Answer: `-221, "Settings conflict"`

:SYSTem:PRESet

The command triggers an instrument reset. It has the same effect as the PRESET key of the manual control or as command *RST. This command triggers an event and hence has no *RST value.

Example: `:SYST:PRES`

:SYSTem:PROTect[1|2|3|4]

The command to disable certain instrument functions is under this node. A list of the functions concerned can be found in the manual control (Chapter 4, Section "Password Input With Protected Functions"). There are four protection levels which are distinguished by means of a suffix after PROT. *RST has no effects on the disabling/enabling of the instrument functions.

:SYSTem:PROTect[1|2|3|4][:STATe] ON | OFF, Password

The command switches a protection level on or off. The passwords are 6-digit numbers. They are fixedly stored in the firmware. The password for the first level is 123456.

ON disables the functions belonging to this protection level. A password doesn't have to be entered.

OFF deactivates the disabling again if the correct password is entered. Otherwise an error -224, "Illegal parameter value" is generated and STATe remains ON.

Example: `:SYST:PROT1:STAT OFF, 123456`

:SYSTem:SECurity[:STATe] ON | OFF

The command switches the security state on or off.

ON The following commands cannot be executed:
`:DISP:ANN:ALL ON`
`:DISP:ANN:FREQ ON`
`:DISP:ANN:AMPL ON`

OFF In the transition from ON to OFF all data existing in the instrument except for the calibrating data are deleted, especially all status registers, all instrument states and all lists.

The command is not influenced by *RST and *RCL.

Example: `:SYST:SEC:STAT ON`

:SYSTem:SERRor?

This command returns a list of all errors existing at the point of time of the query. The error messages are separated by commas. This list corresponds to the indication on the ERROR page with manual control (cf. Chapter 9, Section "Error Messages").

Example: `:SYST:SERR?`
Answer: `-221, "Settings conflict", 153, "Input voltage out of range"`

:SYSTem:VERSion?

The command returns the SCPI version number the instrument acts in accordance with. This command is a query and thus has no *RST value.

Example: `:SYST:VERS?` Answer: `1994.0`

TEST System

This system contains the commands to execute the selftest routines (RAM?, ROM? and BATT?) as well as to directly manipulate the hardware modules (:TEST:DIR). The selftests return a "0" if the test has been executed successfully, otherwise a value unequal to "0". All commands of this system do not have an *RST value.

Caution: *The commands under node :TEST:DIR directly act on the respective hardware module circumventing any security mechanisms. They are provided for service purposes and should not be used by the user. Improper use of the commands may damage the module.*

Command	Parameters	Default Unit	Remark
:TEST			
:DIRect	Address, subaddress, hex data string		
:ASSy	Module, subaddress, hex data string		
:RAM?			Query only
:ROM?			Query only
:BATTery?			Query only

:TEST:DIRect Address, subaddress, hex data string

This node contains the commands directly acting on the respective hardware module circumventing any security mechanisms. The commands under this node have no short form.

:TEST:ASSy Module, subaddress, hex data string

This command addresses the ASSy module. A subaddress (0 or 1) must be entered as a parameter. The data are entered as a <string> (ie an ASCII character string enclosed in inverted commas) representing hexadecimal numbers. The string, therefore, may contain the characters 0 to 9 A to F.

:TEST:RAM?

The command triggers a test of the RAM.

:TEST:ROM?

The command triggers a test of the main memory (EEPROM).

:TEST:BATTery?

The command triggers a test of the battery voltage.

TRIGger System

The TRIGger system contains the commands to select the trigger source and to configure the external trigger socket. The trigger sources for the individual signal sources (RF, LFGen) are distinguished by a numerical suffix appended to TRIG. The suffix conforms to the numbering of the SOURce system:

TRIGger1 = RF generator

TRIGger2 = LFGen

The trigger system of the SML consists of a simplified implementation of the SCPI trigger system. Compared to SCPI, the TRIGger system shows the following differences:

- No INIT command, the instrument behaves as if `:INIT:CONT ON` was set.
- There are several subsystems denoting the different parts of the instrument under TRIGger (SWEep, PULSe).

Further commands as to the trigger system of the SML can be found in the ABORt system.

Command	Parameters	Default Unit	Remark
:TRIGger1|2			
[:SWEep]			
[:IMMediate]			No query
:SOURce	SINGle | EXTernal | AUTO		
:PULSe			
:EGATed			
:POLarity	NORMal | INVerted		
:SOURce	AUTO | EXTernal | EGATed		
:SLOPe	POSitive | NEGative		

:TRIGger1|2[:SWEep]

All commands to trigger a sweep are under this node. The settings here act on level and frequency sweeps for RF generator (TRIG1) or LF generator (TRIG2).

:TRIGger1|2[:SWEep][:IMMediate]

The command immediately starts a sweep. Which sweep is executed depends on the respective Mode setting, e.g. `:SOUR:FREQ:MODE SWE`. The command corresponds to manual-control command Execute Single Sweep. This command triggers an event and thus has no *RST value.

Example: `:TRIG:SWE:IMM`

:TRIGger1|2[:SWEep]:SOURce AUTO | SINGle | EXTernal

The command specifies the trigger source. The naming of the parameters directly corresponds to the different settings with manual control. SCPI uses other designations for the parameters the instrument accepts as well. These designations are to be preferred if compatibility is important. The following table provides an overview.

SML designation	SCPI designation	Command with manual control
AUTO	IMMediate	Mode Auto
SINGle	BUS	Mode Single or Step
EXTernal	EXTernal	Mode Ext Trig Single or Ext Trig Step

AUTO The trigger is free-running, i.e., the trigger requirement is permanently met. As soon as a sweep has been terminated, the next one is started.

SINGle Triggering is effected by means of IEC-bus commands `:TRIG:SWE:IMM` or `*TRG`. If `:SOUR:SWE:MODE` is set to `STEP`, a step, in the case of the `AUTO` setting a complete sweep, is executed.

EXTernal Triggering is effected from outside via the TRIGGER socket or by the GET command via IEC/IEEE-bus. The action triggered depends on the setting of the sweep mode as in the case of SINGle.

Example: `:TRIG:SWE:SOUR AUTO` *RST value is SING

:TRIGger:PULSe

This node contains all commands to trigger the pulse generator (Option SML-B3). The commands are only valid for TRIGger1.

:TRIGger:PULSe:EGATed:POLarity NORMal | INVerted

The command defines the active level of the gate signal.

NORMal Active level = HIGH
INVerted Active level = LOW

Example: `:TRIG:PULS:EGAT:POL INV` *RST value is NORM

:TRIGger:PULSe:SOURce AUTO | EXTernal | EGATed

The command specifies the trigger source.

AUTO Trigger is free-running (see above).
EXTernal Triggering is effected from outside via the PULSE socket.
EGATed Triggering is effected when the gate signal is active.

Example: `:TRIG:PULS:SOUR AUTO` *RST value is AUTO

:TRIGger:PULSe:SLOPe POSitive | NEGative

The command defines whether the action triggered is triggered at the positive or the negative edge of the trigger signal.

Example: `:TRIG:PULS:SLOP NEG` *RST value is POS

List of Commands

Command	Parameter	SCPI info	Page
:ABORt[:SWEep]		not-SCPI	6.6
:CALibration:LEVel:STATe	ON | OFF	not SCPI	6.7
:CALibration:ATTenuator	ON | OFF	not SCPI	6.7
:CALibration:LPReset[:MEASure]?		not SCPI	6.7
:CALibration:LFGenlevel[:MEASure]?		not SCPI	6.7
:CALibration:HARMfilter[:MEASure]?		not SCPI	6.7
:CALibration:MULTfilter[:MEASure]?		not SCPI	6.7
:CALibration:IFFilter[:MEASure]?		not SCPI	6.7
:CALibration:MAINloop[:MEASure]?		not SCPI	6.7
:CALibration:FMOFfset[:MEASure]?		not-SCPI	6.7
:CALibration[:ALL?]		not SCPI	6.8
:CALibration:ROSCillator[:DATA]?		not SCPI	6.8
:CALibration:ROSCillator:STORe		not SCPI	6.8
:DIAGnostic:INFO:CCOunt:POWer?		not-SCPI	6.9
:DIAGnostic:INFO:MODules?		not-SCPI	6.9
:DIAGnostic:INFO:OTIMe?		not-SCPI	6.9
:DIAGnostic:INFO:SDATe?		not-SCPI	6.10
:DIAGnostic[:MEASure]:POINt?		not-SCPI	6.10
:DISPlay:ANNotation[:ALL]	ON | OFF		6.11
:DISPlay:ANNotation:AMPLitude	ON | OFF		6.11
:DISPlay:ANNotation:FREQuency	ON | OFF		6.11
:MEMory:NSTates?			6.12
:OUTPut1:AMODe	AUTO | FIXed	not-SCPI	6.12
:OUTPut3:POLarity:PULSe	NORMal | INVerse		6.13
:OUTPut3:POLarity:VIDeo	NORMal | INVerse		6.13
:OUTPut3:SOURce	OFF | PULSegen | VIDeo		6.13
:OUTPut1|2[:STATe]	ON | OFF		6.13
:OUTPut1[:STATe]:PON	OFF | UNCHanged	not-SCPI	6.13
:OUTPut2:VOLTage	0 V to 4 V	not-SCPI	6.14
[:SOURce]:AM[:DEPTh]	0 to 100 PCT		6.14
[:SOURce]:AM:EXTernal:COUPling	AC | DC		6.15
[:SOURce]:AM:INTernal:FREQuency	0.1 Hz to 10 MHz		6.15
[:SOURce]:AM:SOURce	EXTernal | INTernal | TTONe		6.15
[:SOURce]:AM:STATe	OFF | ON		6.15
[:SOURce]:CORRection[:STATe]	ON | OFF		6.16
[:SOURce]:CORRection:CSET:CATalog?		not-SCPI	6.16
[:SOURce]:CORRection:CSET:FREE?		not-SCPI	6.16
[:SOURce]:CORRection:CSET[:SELect]	'name of table'		6.17
[:SOURce]:CORRection:CSET:DATA:FREQuency	9 kHz to 3.3 GHz {,9 kHz to 3.3 GHz }	not-SCPI	6.17
[:SOURce]:CORRection:CSET:DATA:POWer	+20 to -20dB {,+20 to -20dB }	not-SCPI	6.17
[:SOURce]:CORRection:CSET:DATA:POWer:POINts?		not-SCPI	6.17
[:SOURce]:CORRection:CSET:DELete	'name of table'	not-SCPI	6.17

Command	Parameter	SCPI info	Page
[:SOURce]:FM[:DEViation]	0 kHz to 20/40 MHz	not-SCPI	6.19
[:SOURce]:FM:EXTernal:COUPling	AC | DC		6.19
[:SOURce]:FM:INTernal:FREQuency	0.1 Hz to 10 MHz		6.20
[:SOURce]:FM:SOURce	EXTernal | INTernal | TTONe		6.20
[:SOURce]:FM:STATe	ON | OFF		6.20
[:SOURce]:FM:BANDwidth	STANdard | WIDE		6.20
[:SOURce]:FREQuency:CENTer	9 kHz to 3.3 GHz		6.21
[:SOURce]:FREQuency[:CW | :FIXed]	9 kHz to 1.1 GHz		6.21
[:SOURce]:FREQuency:RCL	INCLude | EXCLude		6.21
[:SOURce]:FREQuency:MANual	9 kHz to 3.3 GHz		6.21
[:SOURce]:FREQuency:MODE	CW | FIXed | SWEep		6.22
[:SOURce]:FREQuency:OFFSet	-50 to +50 GHz		6.22
[:SOURce]:FREQuency:SPAN	3.3 GHz – 9 kHz		6.22
[:SOURce]:FREQuency:STARt	9 kHz to 3.3 GHz		6.22
[:SOURce]:FREQuency:STOP	9 kHz to 3.3 GHz		6.22
[:SOURce]:FREQuency:STEP[:INCRement]	0 to 1 GHz / 0 to 2 GHz / 0 to 3 GHz		6.22
[:SOURce]:FREQuency:ERANge	ON | OFF		6.22
[:SOURce]:PHASe[:STEP]	-360 to 360 EG	not-SCPI	6.23
[:SOURce]:PHASe.REFerence		not-SCPI	6.23
[:SOURce]:FREQuency:STATe	ON | OFF	not-SCPI	6.23
[:SOURce]:PM[:DEViation]	0 to 10 RAD	not-SCPI	6.24
[:SOURce]:PM:EXTernal:COUPling	AC | DC		6.24
[:SOURce]:PM:INTernal:FREQuency	0.1 Hz to 10 MHz		6.24
[:SOURce]:PM:SOURce	EXTernal | INTernal | TTONe		6.25
[:SOURce]:PM:STATe	ON | OFF		6.25
[:SOURce]:PM:BANDwidth	STANdard | WIDE		6.25
[:SOURce]:POWer:ALC:SEArch?			6.26
[:SOURce]:POWer:ALC[:STATe]	ON | OFF		6.26
[:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude]	–130 dBm to +25 dBm		6.27
[:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude]:OFFSet	-100 to +100 dB		6.27
[:SOURce]:POWer:LIMit[:AMPLitude]	-130 dBm to +25 dBm		6.27
[:SOURce]:POWer:MANual	–130 dBm to +25 dBm		6.27
[:SOURce]:POWer:MODE	CW | FIXed | SWEep		6.27
[:SOURce]:POWer:RCL	INCLude | EXCLude		6.27
[:SOURce]:POWer:STARt	-130 dBm to +25 dBm		6.28
[:SOURce]:POWer:STOP	-130 dBm to +25 dBm		6.28
[:SOURce]:POWer:STEP[:INCRement]	0.1 to 10 dB		6.28
[:SOURce]:PULM:POLarity	NORMal | INVerse		6.29
[:SOURce]:PULM:SOURce	EXTernal | INTernal		6.29
[:SOURce]:PULM:STATe	ON | OFF		6.29
[:SOURce]:PULSe:DELay	20 ns to 1.3 s		6.30
[:SOURce]:PULSe:DOUBle:DELay	60 ns to 1.3 s		6.30
[:SOURce]:PULSe:DOUBle[:STATe]	ON | OFF		6.30
[:SOURce]:PULSe:PERiod	100 ns to 85 s		6.30

Command	Parameter	SCPI info	Page
[:SOURce]:PULSe:WIDTh	20 ns to 1.3 s		6.30
[:SOURce]:ROSCillator[:INTernal]:ADJust[:STATe]	ON | OFF	not-SCPI	6.31
[:SOURce]:ROSCillator[:INTernal]:ADJust:VALue	0 to +4095	not-SCPI	6.31
[:SOURce]:ROSCillator[:INTernal]:RLOop	NORMal | NARRow	not-SCPI	6.31
[:SOURce]:ROSCillator:SOURce	INTernal | EXTernal		6.31
[:SOURce]:STEReo:ARI		not-SCPI	6.33
[:SOURce]:STEReo:ARI:BK[:CODE]	A | BI | C | D | E | F	not-SCPI	6.33
[:SOURce]:STEReo:ARI[:DEViation]	0 to 10 kHz	not-SCPI	6.33
[:SOURce]:STEReo:ARI:STATe	ON | OFF	not-SCPI	6.33
[:SOURce]:STEReo:TYPE:	DK | BK | BKDK	not-SCPI	6.33
[:SOURce]:STEReo:ARI:TYPE:STATe	ON | OFF	not-SCPI	6.33
[:SOURce]:STEReo:AUDio		not-SCPI	6.33
[:SOURce]:STEReo:AUDio:MODE	LEFT | RIGHt | RELeft | REMLeft| RNELeft	not-SCPI	6.33
[:SOURce]:STEReo:AUDio[:FREQency]	0.1 Hz to 1 MHz	not-SCPI	6.34
[:SOURce]:STEReo:AUDio:PREemphasis	50 us | 75 us	not-SCPI	6.34
[:SOURce]:STEReo:AUDio:PREemphasis:STATe	ON | OFF	not-SCPI	6.34
[:SOURce]:STEReo:EXTernal:IMPedance	600 Ohm | 100 kOhm	not-SCPI	6.34
[:SOURce]:STEReo[:DEViation]	0 to 80 kHz	not-SCPI	6.34
[:SOURce]:STEReo:DIRect	String	not-SCPI	6.34
[:SOURce]:STEReo:PILot		not-SCPI	6.34
[:SOURce]:STER:PILot[:DEViation]	0 to 10 kHz	not-SCPI	6.34
[:SOURce]:STEReo:PILot:PHAse	-5 to 5 DEG		6.34
[:SOURce]:STEReo:PILot:STATe	ON | OFF		6.35
[:SOURce]:STEReo:RDS			6.35
[:SOURce]:STEReo:RDS:DATaset	DS1 | DS2 | DS3 | DS4 | DS5		6.35
[:SOURce]:STEReo:RDS[:DEViation]	0 to 10 KHz		6.35
[:SOURce]:STEReo:RDS:STATe	ON | OFF		6.35
[:SOURce]:STEReo:RDS:TRAFfic:PROGram:STATe	ON | OFF		6.35
[:SOURce]:STEReo:RDS:TRAFfic:ANNouncement[:STATe]	ON | OFF		6.35
[:SOURce]:STEReo:SOURce	LREXt | SPEXt | LFGen		6.35
[:SOURce]:STEReo:STATe	ON | OFF		6.35
[:SOURce]:SWEep[:FREQuency]:DWELl	10 ms to 5 s	not-SCPI	6.36
[:SOURce]:SWEep[:FREQuency]:MODE	AUTO | MANual | STEP	not-SCPI	6.36
[:SOURce]:SWEep[:FREQuency]:SPACing	LINear | LOGarithmic	not-SCPI	6.36
[:SOURce]:SWEep[:FREQuency]:STEP[:LINear]	0 to 1 GHz / 0 to 2 GHz / 0 to 3 GHz	not-SCPI	6.37
[:SOURce]:SWEep[:FREQuency]:STEP:LOGarithmic	0.01 to 10PCT	not-SCPI	6.37
[:SOURce]:SWEep:POWer:DWELl	10 ms to 5 s	not-SCPI	6.37
[:SOURce]:SWEep:POWer:MODE	AUTO | MANual | STEP	not-SCPI	6.37
[:SOURce]:SWEep:POWer:SPACing	LOGarithmic	not-SCPI	6.37
[:SOURce]:SWEep:POWer:STEP[:LOGarithmic]	0 to 160 dB	not-SCPI	6.38
:SOURce2:FREQuency[:CW | :FIXed]	0.1 Hz to 1 MHz		6.39
:SOURce2:FREQuency:MANual	0.1 Hz to 1 MHz		6.39
:SOURce2:FREQuency:MODE	CW | FIXed | SWEep		6.40
:SOURce2:FREQuency:STARt	0.1 Hz to 1 MHz		6.40

Command	Parameter	SCPI info	Page
:SOURce2:FREQuency:STOP	0.1 Hz to 1 MHz		6.33
:SOURce2:SWEep[:FREQuency]:DWELl	10 ms to 5 s	not-SCPI	6.41
:SOURce2:SWEep[:FREQuency]:MODE	AUTO | MANual | STEP	not-SCPI	6.41
:SOURce2:SWEep[:FREQuency]:SPACing	LINear | LOGarithmic	not-SCPI	6.41
:SOURce2:SWEep[:FREQuency]:STEP[:LINear]	0 to 1 MHz	not-SCPI	6.42
:SOURce2:SWEep[:FREQuency]:STEP:LOGarithmic	0.01 to 100PCT	not-SCPI	6.42
:STATus:PRESet			6.43
:STATus:QUEue [:NEXT]?			6.43
:SYSTem:COMMunicate:GPIB[:SELF]:ADDRess	1 to 30		6.44
:SYSTem:COMMunicate:SERial:BAUD	1200| 2400| 4800| 9600| 19200| 38400| 57600| 115200		6.45
:SYSTem:COMMunicate:SERial:BITS	7 | 8		6.45
:SYSTem:COMMunicate:SERial:SBITs	1 | 2		6.45
:SYSTem:COMMunicate:SERial:CONTrol:RTS	ON | IBFull | RFR		6.45
:SYSTem:COMMunicate:SERial:PACE	XON | NONE		6.45
:SYSTem:COMMunicate:SERial:PARity	ODD | EVEN | NONE		6.45
:SYSTem:DISPlay:UPDate[:STATe]	ON | OFF		6.45
:SYSTem:ERRor?			6.45
:SYSTem:PRESet			6.46
:SYSTem:PROTect[1|2|3|4][:STATe]	ON | OFF, Password	not-SCPI	6.46
:SYSTem:SECurity[:STATe]	ON | OFF		6.46
:SYSTem:SERRor?		not-SCPI	6.46
:SYSTem:VERSion?			6.46
:TEST:DIRect	Address, subaddress, hex data string		6.47
:TEST:ASSy	Module, subaddress, Hex data string		6.47
:TEST:RAM?			6.47
:TEST:ROM?			6.47
:TEST:BATTery?			6.47
:TRIGger1|2[:SWEep][:IMMediate]		not-SCPI	6.48
:TRIGger1|2[:SWEep]:SOURce	AUTO | SINGle | EXTernal	not-SCPI	6.49
:TRIGger:PULSe:EGATed:POLarity	NORMal | INVerted	not-SCPI	6.49
:TRIGger:PULSe:SOURce	AUTO | EXTernal | EGATed	not-SCPI	6.49
:TRIGger:PULSe:SLOPe	POSitive | NEGative	not-SCPI	6.49

7 Remote Control - Programming Examples

The examples explain the programming of the instrument and can serve as a basis to solve more complex programming tasks.

QuickBASIC has been used as programming language. However, the programs can be translated into other languages.

Including IEC-Bus Library for QuickBasic

```
REM ------ Include IEC-bus library for quickbasic -------
'$INCLUDE: 'c:\qbasic\qbdecl4.bas'
```

Initialization and Default Status

The IEC bus as well as the settings of the instrument are brought into a defined default status at the beginning of every program. Subroutines "InitController" and "InitDevice" are used to this effect.

Initiate Controller

```
REM ------------ Initiate Instrument -----------
REM InitController
iecaddress% = 28                        'IEC-bus address of the instrument
CALL IBFIND("DEV1", generator%)         'Open port to the instrument
CALL IBPAD(generator%, iecaddress%)     'Inform controller on instrument address
CALL IBTMO(generator%, 11)              'Response time to 1 sec
REM ***************************************************************************
```

Initiate Instrument

The IEC-bus status registers and instrument settings of the SML are brought into the default status.

```
REM ------------ Initiate Instrument --------------
REM InitDevice
CALL IBWRT(generator%, "*CLS")          'Reset status register
CALL IBWRT(generator%, "*RST")          'Reset instrument
CALL IBWRT(generator%, "OUTPUT ON")     'Switch on RF output
REM***************************************************************************
```

Transmission of Instrument Setting Commands

Output frequency, output level and AM modulation are set in this example. By analogy to the step width setting of the rotary knob, the step width is additionally set for the alteration of the RF frequency in the case of UP and DOWN.

```
REM -------- Instrument setting commands -------------
CALL IBWRT(generator%, "FREQUENCY 250E6")  'RF Frequency 250 MHz
CALL IBWRT(generator%, "POWER -10")        'Output power -10 dBm
CALL IBWRT(generator%, "AM 80")            'AM with modulaton index of 80%
CALL IBWRT(generator%, "AM:INTERNAL:FREQUENCY 3KHZ")
                                           'Modulation frequency 3kHz
CALL IBWRT(generator%, "AM:SOURCE INT")    'Modulation source LF generator
CALL IBWRT(generator%, "FREQUENCY:STEP 12000")
                                           'Step width RF frequency 12 kHz
REM ************************************************************************
```

Switchover to Manual Control

```
REM -------- Switch instrument over to manual control -------
CALL IBLOC(generator%)                'Set instrument to Local state
REM ************************************************************************
```

Reading out Instrument Settings

The settings made in the example above are read out here. The abbreviated commands are used.

```
REM --------- Reading out instrument settings -------------
RFfrequency$ = SPACE$(20)          'Provide text variables with 20 characters
CALL IBWRT(generator%, "FREQ?")    'Request frequency setting
CALL IBRD(generator%, RFfrequency$) 'Read value

RFlevel$ = SPACE$(20)              'Provide text variables with 20 characters
CALL IBWRT(generator%, "POW?")     'Request level setting
CALL IBRD(generator%, RFlevel$)    'Read value

AMmodulationdepth$ = SPACE$(20)    'Provide text variables with 20 characters
CALL IBWRT(generator%, "AM?")      'Request setting of modulation depth
CALL IBRD(generator%, AMmodulationdepth$)'Read value

AMfrequency$ = SPACE$(20)          'Provide text variables with 20 characters
CALL IBWRT(generator%, "AM:INT:FREQ?") 'Request setting of modulation frequency
CALL IBRD(generator%, AMfrequency$) 'Read value

Stepwidth$ = SPACE$(20)            'Provide text variables with 20 characters
CALL IBWRT(generator%, "FREQ:STEP?") 'Request step width setting
CALL IBRD(generator%, Stepwidth $)  'Read value

REM -------- Display values on the screen -------------
PRINT "RF frequency:          "; RFfrequency$,
PRINT "RF level:              "; RFlevel$,
PRINT "AM modulationdepth:    "; AMmodulationdepth$,
PRINT "AM frequency:          "; AMfrequenz$,
PRINT "Step width:            "; stepwidth$
REM************************************************************************
```

Command synchronization

The possibilities for synchronization implemented in the following example are described in Chapter 5, Section "Command Order and Command Synchronization".

```
REM -------- Examples of command synchronization ---------
REM Command ROSCILLATOR:SOURCE INT has a relatively long execution time
REM (over 300ms). It is to be ensured that the next command is only executed
REM when the reference oscillator has settled.

REM -------- First possibility: Use of *WAI ------------
CALL IBWRT(generator%, "ROSCILLATOR:SOURCE INT; *WAI; :FREQUENCY 100MHZ")

REM -------- Second possibility: Use of *OPC? --------
OpcOk$ = SPACE$(2)                    'Space for *OPC? - Provide response
CALL IBWRT(generator%, "ROSCILLATOR:SOURCE INT; *OPC?")
REM -------- here the controller can service other instruments -----------
CALL IBRD(generator%, OpcOk$)          'Wait for "1" from *OPC?

REM -------- Third possibility: Use of *OPC
REM In order to be able to use the service request function in conjugation
REM with a National Instruments GPIB driver, the setting "Disable Auto
REM Serial Poll" must be changed to "yes" by means of IBCONF.

CALL IBWRT(generator%, "*SRE 32")     'Permit service request for ESR
CALL IBWRT(generator%, "*ESE 1")      'Set event-enable bit for
                                      'operation-complete bit
ON PEN GOSUB OpcReady          'Initialization of the service request routine
PEN ON
CALL IBWRT(generator%, "ROSCILLATOR:SOURCE INT; *OPC")
REM Continue main program here.
STOP                                  'End of program

OpcReady:
REM As soon as the reference oscillator has settled, this subroutine is
REM  activated
REM  Program suitable reaction to the OPC service request.
ON PEN GOSUB OpcReady                 'Enable SRQ routine again
RETURN
REM ************************************************************************
```

Service Request

The service request routine requires an extended initialization of the instrument in which the respective bits of the transition and enable registers are set.
In order to be able to use the service request function in conjugation with a National Instruments GPIB driver, the setting "Disable Auto Serial Poll" must be changed to "yes" by means of IBCONF.

```
REM ---- Example of initialization of the SRQ in the case of errors ------
CALL IBWRT(generatot%, "*CLS")        'Reset status reporting system
CALL IBWRT(generator%,"*SRE 168")     'Permit service request for STAT:OPER-,
                                      'STAT:QUES- and ESR register
CALL IBWRT(generator%,"*ESE 60")      'Set event-enable bit for command, exe-
                                      'cution, device-dependent and query error
ON PEN GOSUB Srq                              'Initialization of the service
                                              'request routine
PEN ON
REM Continue main program here
STOP                                          'End of program
```

A service request is then processed in the service request routine.

Note: The variables userN% and userM% must be pre-assigned usefully.

```
Srq:
REM ------------ Service request routine -----------
DO
  SRQFOUND% = 0
  FOR I% = userN% TO userM%                   'Poll all bus users
      ON ERROR GOTO nouser                    'No user existing
      CALL IBRSP(I%, STB%)                    'Serial poll, read status byte
      IF STB% > 0 THEN                        'This instrument has bits set
                                              'in the STB
        SRQFOUND% = 1
        IF (STB% AND 16)  > 0 THEN GOSUB Outputqueue
        IF (STB% AND 4)   > 0 THEN GOSUB Failure
        IF (STB% AND 32)  > 0 THEN GOSUB Esrread
      END IF
nouser:
  NEXT I%
LOOP UNTIL SRQFOUND% = 0
ON ERROR GOTO error handling
ON PEN GOSUB Srq: RETURN                      'Enable SRQ routine again;
                                              'End of SRQ routine
```

Reading out the status event registers, the output buffer and the error/event queue is effected in subroutines.

```
REM -------- Subroutines for the individual STB bits ------
Outputqueue:                                    'Reading the output buffer
Message$ = SPACE$(100)                          'Make space for response
CALL IBRD(generator%, Message$)
PRINT " Message in output buffer :"; Message$
RETURN

Failure:                                        'Read error queue
ERROR$ = SPACE$(100)                            'Make space for error variable
CALL IBWRT(generator%, "SYSTEM:ERROR?")
CALL IBRD(generator%, ERROR$)
PRINT "Error text :"; ERROR$
RETURN



Esrread:                            'Read Event status register
Esr$ = SPACE$(20)                   'Preallocate blanks to text variable
CALL IBWRT(generator%, "*ESR?")     'Read ESR
CALL IBRD(generator%, Esr$)
IF (VAL(Esr$) AND 1) > 0 THEN PRINT "Operation complete"
IF (VAL(Esr$) AND 4) > 0 THEN GOTO Failure
IF (VAL(Esr$) AND 8) > 0 THEN PRINT "Device dependent error"
IF (VAL(Esr$) AND 16) > 0 THEN GOTO Failure
IF (VAL(Esr$) AND 32) > 0 THEN GOTO Failure
IF (VAL(Esr$) AND 64) > 0 THEN PRINT "User request"
IF (VAL(Esr$) AND 128) > 0 THEN PRINT "Power on"
RETURN
REM ************************************************************************

REM ------------- Error routine ----------------
Error handling:
PRINT "ERROR"                                   'Output error message
STOP                                            ' Stop software
```

8 Maintenance

The present chapter describes the measures that are necessary for maintaining, storing and packing the instrument.

The instrument does not need a periodic maintenance. What is necessary is essentially the cleaning of the outside of the instrument.
However, it is recommended to check the rated data from time to time.

Cleaning the Outside

The outside of the instrument is suitably cleaned using a soft, line-free dustcloth.

Caution! *Do not use solvents such as thinners, acetone and similar things in any case, because otherwise the front panel labeling or plastic parts will be damaged.*

Storing and Packing

The instrument can be stored at a temperature of –40° C to +70° C. When stored for an extended period of time, the instrument should be protected against dust.

The original packing should be used, particularly the protective covers at the front and rear, when the instrument is to be transported or dispatched. If the original packing is no longer available, use a sturdy cardboard box of suitable size and carefully wrap the instrument to protect it against mechanical damage.

Exchanging the Lithium Battery

A lithium battery with a service life of approx. 5 years serves to supply the RAM with power. When the battery is discharged, the data stored will be lost. Exchanging the battery is described in the Service Manual.

9 Error Messages

The present chapter contains the error messages (short-term and long-term messages) of the SML.

Short-term message

The short-term message is displayed in the status line. Part of it overwrites the status indications and disappears after approx. 2 seconds or in the case of a new entry.
The instrument shows, e.g., short-term messages if the attempt is made to enter an overrange or if incompatible operating modes deactivate one another.

Long-term message

The long-term message is displayed in the status line by means of the message "Err". Pressing the [ERROR] key calls the ERROR page in which the messages are entered. Several messages can be entered at the same time. The long-term message remains existing until there is no cause any more. The ERROR page is exited using the [BACK] key.

The ERROR page offers access to long-term messages if the [ERROR] key is pressed.

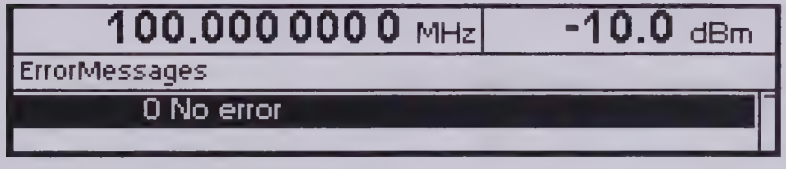


Fig. 9-1 ERROR page

Notes:

- *An error message "Err" does not necessarily point to a defect instrument. There are various operating states which can cause an ERROR message, e.g. if the instrument is set to external reference but no external reference is connected.*
- *Error -313 indicates the loss of calibration data and is also applicable in case of a cold start (key [PRESET] is pressed during switch-on). The calibration values can be restored with internal calibration routines. These routines are accessible via menu Utilities - Calib (see section on calibration).*

List of Error Messages

The following list contains all SCPI- and device-specific error messages for errors occurring in the instrument. The meaning of negative error codes is defined in SCPI, positive error codes mark device-dependent errors.

The lefthand column of the table below contains the error code. In the righthand column, the error text entered into the error/event queue and shown on the display is in bold type. Below the error text there is an explanation of the error.

SCPI-Specific Error Messages

No error

Error code	Error text with queue poll Explanation of error
0	**No error** This message is output if the error queue contains no entries.

Command Error – errored command; sets bit 5 in the ESR register

Error code	Error text with queue poll Explanation of error
-100	**Command error** The command is errored or invalid.
-101	**Invalid character** The command contains an invalid character. Example: A header contains an ampersand, "SOURCE&".
-102	**Syntax error** The command is invalid. Example: A command contains block data which the instrument does not accept.
-103	**Invalid separator** The command contains an illegal character instead of a terminator. Example: A semicolon after the command is missing.
-104	**Data type error** The command contains an invalid value information. Example: ON is entered instead of a numerical value for frequency setting.
-105	**GET not allowed** A Group Execute Trigger (GET) is entered within a command line.
-108	**Parameter not allowed** The command contains too many parameters. Example: The command SOURce:FM:INTernal:FREQuency allows for a frequency entry only.
-109	**Missing parameter** The command contains too few parameters. Example: The command SOURce:FM:INTernal:FREQuency requires a frequency entry.

Command Error, continued

Error code	Error text with queue poll Explanation of error
-112	**Program mnemonic too long** The header contains more than 12 characters.
-113	**Undefined header** The header is not defined for the instrument. Example: `*XYZ` is undefined for every instrument.
-114	**Header suffix out of range** The header contains an illegal numerical suffix. Example: `SOURce3` does not exist in the instrument.
-123	**Exponent too large** The absolute value of the exponent is larger than 32000.
-124	**Too many digits** The number contains too many digits.
-128	**Numeric data not allowed** The command contains a number which is not allowed at this position. Example: The command `SOURce:FREQuency:MODE` requires the entry of a text parameter.
-131	**Invalid suffix** The suffix is invalid for this instrument. Example: nHz is not defined.
-134	**Suffix too long** The suffix contains more than 12 characters.
-138	**Suffix not allowed** A suffix is not allowed for this command or at this position of the command. Example: The command `*RCL` does not allow for a suffix to be entered.
-141	**Invalid character data** The text parameter either contains an invalid character or it is invalid for this command. Example: spelling mistake in parameter entry; `SOURce:FREQuency:MODE FIKSed`.
-144	**Character data too long** The text parameter contains more than 12 characters.
-148	**Character data not allowed** The text parameter is not allowed for this command or at this position of the command. Example: The command `*RCL` requires the entry of a number.
-158	**String data not allowed** The command contains a valid character string at a position which is not allowed. Example: A text parameter is entered in inverted commas, eg `SOURce:FREQuency:MODE "FIXed"`
-161	**Invalid block data** The command contains errored block data. Example: An END message was received before the expected number of data was received.
-168	**Block data not allowed** The command contains valid block data at a position which is not allowed. Example: The command *RCL requires the entry of a number.
-178	**Expression data not allowed** The command contains a mathematical expression at a position which is not allowed.

Execution Error – error in the execution of a command; sets bit 4 in the ESR register

Error code	Error text with queue poll Explanation of error
-203	**Command protected** The desired command could not be executed as it is protected by a password. Use the command `SYSTem:PROTect OFF,` <password> to enable the desired command. Example: The command `CALibrate:PULSe:MEASure?` is password-protected.
-211	**Trigger ignored** The trigger (GET, *TRG or trigger signal) was ignored because of the instrument timing control. Example: The instrument was not ready to answer.
-221	**Settings conflict** The settings of two parameters are conflicting. Example: FM and PM cannot be switched on at the same time.
-222	**Data out of range** The parameter value is out of the permissible range of the instrument. Example: The command *RCL only permits entries between 0 and 50.
-223	**Too much data** The command contains too many data. Example: The instrument does not have sufficient memory space.
-224	**Illegal parameter value** The parameter value is invalid. Example: An invalid text parameter is entered, eg `TRIGger:SWEep:SOURce TASTe`
-225	**Out of memory** The available instrument memory space is exhausted. Example: An attempt was made to create more than 10 lists.
-226	**Lists not of same length** The parts of a list have different lengths. This error message is also displayed if only part of a list has been transmitted via the IEC/IEEE bus. All parts of a list have to be transmitted before the list is executed. Example: The POWer part of a list is longer than the FREQuency part, or only the POWer part has been transmitted.
-230	**Data corrupt or stale** The data are incomplete or invalid. Example: The instrument has aborted a measurement.
-240	**Hardware error** The command cannot be executed because of a hardware fault of the instrument.
-241	**Hardware missing** The command cannot be executed because of hardware missing. Example: An option is not fitted.
-255	**Directory full** The list management cannot accept any more lists since the maximum number of lists has already been attained. Example: An attempt was made to create more than the allowed number of UCOR lists.

Device Specific Error - sets bit 3 in the ESR register

Error code	Error text with queue poll Explanation of error
-310	**System error** This error message suggests an error within the instrument. Please inform your R&S service center.
-311	**Memory error** Error in instrument memory.
-313	**Calibration memory lost** Loss of stored calibration data. The YFOM and ALC AMP calibration data can be restored by means of internal routines (see chapter 4, section "Calibration").
-314	**Save/recall memory lost** Loss of the nonvolatile data stored with the command *SAV?.
-315	**Configuration memory lost** Loss of the nonvolatile configuration data stored by the instrument.
-330	**Self-test failed** The self-test could not be executed.
-350	**Queue overflow** This error code is entered into the error queue instead of the actual error code when the error queue is full. The code indicates that an error has occurred but has not been accepted. The error queue can accept 5 entries.
-360	**Communication error** An error has occurred during the transmission or reception of data on the IEC/IEEE bus or via the RS-232-C interface.

Query Error – error in data request; sets bit 2 in the ESR register

Error code	Error text with queue poll Explanation of error
-410	**Query INTERRUPTED** The query was interrupted. Example: After a query, the instrument receives new data before the response has been sent completely.
-420	**Query UNTERMINATED** The query is incomplete. Example: The instrument is addressed as a talker and receives incomplete data.
-430	**Query DEADLOCKED** **The query cannot be processed**. Example: The input and output buffers are full; the instrument cannot continue operating.

SML-Specific Error Messages

Device-dependent Error – device-specific error; sets bit 3 in the ESR register.

Error code	Error text in the case of queue poll Error explanation
110	**Output unleveled** The level control loop is deactivated.
115	**Level overrange** The level is above the limit value guaranteed.
116	**Level underrange** The level is below the limit value guaranteed.
117	**Dynamic level range exceeded** The difference between the maximal and minimal value of a level list is above 20 dBm. An exact level setting is no longer guaranteed.
135	**Pulse input signal missing** No pulse input signal available.
140	**This modulation forces other modulations OFF** A modulation has been switched on which cannot be used at the same time as an already active modulation. The previous modulation has been switched off.
171	**Oven cold** The reference oscillator has not yet reached its operating temperature.
180	**Calibration failed** Calibration could not be executed.
181	**REF OSC calibration data not used because ADJUSTMENT STATE is ON** The reference-oscillator calibration data are not used as long as ADJUSTMENT STATE is activated.
200	**Cannot access hardware** The data transmission to a module was unsuccessful.
201	**Function not supported by this hardware revision** A later version of certain parts of the instrument is necessary to execute the function selected.
202	**Diagnostic A/D converter failure** Diagnostic A/D converter has failed.
241	**No list defined** There is no list defined..
243	**Dwell time adjusted** A dwell time given on a list cannot be processed by the unit. The setting was automatically adjusted.
251	**No User Correction Table; zero assumed** An attempt has been made to switch on user correction, but no UCOR table has been stored in the instrument yet. The instrument behaves as if a table was called which only contains 0-values.
260	**Invalid keyboard input ignored** An invalid input via the keyboard is not considered.
265	**This parameter is read only** An attempt has been made to change a fixedly specified value.

Continuation: Device-dependent Error

Error code	Error text in the case of queue poll Error explanation
270	**Data output aborted** Data output was aborted on the IEC/IEEE-bus. Example: The key [LOCAL] was pressed.
304	**String too long** A character string which is too long was received via the IEC bus. The names of lists may have a length of maximally seven letters.
305	**Fill pattern too long; trunctated** More data have been entered with block function FILL in the list editor than the filling range (RANGE) set permits. The exceeding data are ignored.
306	**No fill pattern specified** An attempt was made to execute a filler function without having to indicate a filler pattern.

Possible Error Sources

The error messages issued by the continuous monitoring of diagnosis points are described in the following table. Troubleshooting should be performed according to the order given in the table since an error mentioned further down could be caused by those above.

Table 9-1 Error messages of hardware monitoring

Displayed message	Error	Possible source
174,"Reference PLL unlocked"	The PLL of the 800 MHz reference oscillator on the main board is out of synchronization: = > Output frequency not correct	If unit is set to external reference: - No external reference signal at the 10 MHz REF connector (rear of unit) - Level or frequency of external reference does not correspond to data sheet value
175,"Main PLL unlocked"	The PLL of the main oscillator on the main board is out of synchronization: => Output frequency not correct	- Calibration is missing or erroneous for example after an exchange of modules or batteries
110,"Output unleveled; OPU1"	The level control for the output level on the main board is switched off: => Output level not correct	- Level outside the specified range - Overload at AM-EXT-DC Calibration is missing or erroneous for example after an exchange of modules or batteries

Error messages issued as a result of loss of data, for example on exchanging a battery or software update are listed in the following table.

Table 9-2 Error messages as a result of loss of data

Displayed messages	Error	Possible source and troubleshooting
-313,"Calibration memory lost ; XXXXXXXXX", [1]	Internal calibration data are missing	- Data loss due to low battery voltage - Data loss due to software update - Data loss due to "Factory Preset" Possible troubleshooting: - Perform internal calibration (see chapter 4)
-313,"Calibration memory lost; Reference Oscillator",	Calibration value is missing	- Loss of non-volatile EEPROM data Possible troubleshooting: - Adjustment of 10 MHz reference frequency (see SML service manual)
-315,"Configuration memory lost"	One or more EEPROM data blocks are missing	- Loss of non-volatile EEPROM data

[1] where XXXXXXX indicates the name of the missing calibration : IF Filter, Main Loop, Harmonic Filter, Mult Filter, Level Preset, Lfgen Level, FM Offset

10 Performance Test

The present Performance Test is valid for model SML01.02, 03.

Preliminary Remark

- The rated characteristics of the signal generator are checked after a warm-up time of at least 15 minutes. A recalibration of the unit is not required. FM offset calibration is an exception, however.
- A defined default state is set prior to each measurement by pressing the **PRESET** key.
- The values stated hereafter are not guaranteed values. Only the data sheet specifications shall be binding.
- The values specified in the data sheet are guaranteed limits. The tolerances of the instruments used in the performance test must be added to the limits because of their measurement uncertainty.

Measuring Equipment and Accessories

Table 10-1 Measuring equipment and accessories

Item	Instrument type	Recommended characteristics	Suitable unit	R&S Order No.	Use/measurement
1	Frequency counter	Frequency range up to 1100 MHz. Internal reference 10 MHz	Contained in item 2 or 10		Frequency accuracy
2	RF spectrum analyzer	Frequency range up to 1100 MHz	FSEA30	1065.6000.30	Settling time level accuracy Output reflection coefficient Harmonics Spurious Pulse modulation
3	Signal generator with high spectral purity	Phase noise at 1 GHz: typ. <-128 dBc/Hz at 20 kHz	SME03 SMHU	1038.6002.03 0835.0011.52	output reflection coefficient SSB phase noise Broadband noise
4	Storage oscilloscope	DC 100 MHz, 0.1V/div			SSB phase noise Pulse modulation
5	Phase noise test set	Mixer: 10 MHz to 1100 MHz Lowpass filter: approx. 500 kHz Preamplifier with gain of approx. 30 dB, input noise <2 nV (1 Hz), DC decoupling after mixer for oscilloscope			SSB phase noise
6	RF power meter	9 kHz to 1100 MHz	NRVS with NRV-Z51	1020.1809.02 0857.9004.02	Level accuracy Non-interrupting level setting

Item	Instrument type	Recommended characteristics	Suitable unit	R&S Order No.	Use/measurement
7	Precision attenuators	Frequency range 9 kHz to 1100 MHz Attenuation 0 to 125 dB I = 50 Ω	RSP	0831.3515.02	Level accuracy
8	Controller	IEC-625-1 interface			Settling time
9	SWR bridge	1 MHz to 1100 MHz Directivity >40 dB	ZRC	1039.9492.55/ 1039.9492.52	Output reflection coefficient
10	Modulation analyzer	100 kHz to 1100 MHz, AM, FM, PhiM, stereo coder, stereo decoder, distortion meter, weighting filter ITU-R, ITU-T	FMB with option FMA-B1, FMA-B2, FMA-B3, FMA-B4	856.5005.52 855.2002.52 855.0000.52 856.0003.52 855.6008.52	Residual FM Residual AM AM/FM/PhiM modulation LF generator Stereo modulation
11	Sinewave generator	10 Hz to 500 kHz, 8 V (V_{peak})	ADS AFG	1012.4002.02 0377.2100.02	AM/FM/PhiM modulation Overvoltage protection
12	AC/DC voltmeter	DC to 1 MHz	URE3	350.5315.03	LF generator
13	Low-noise preamplifier	5 kHz to 1100 MHz Gain >20 dB, Noise figure <10 dB			Level accuracy
14	Audio analyzer	10Hz to100kHz	UPL06/UPL-B29 with BNC/SLRAdaptors	1078.2008.05	RDS/Stereo Coder SML-B5
15	RDS decoder		DMDC	0820.6618.03	RDS/Stereo Coder SML-B5

Test Setups

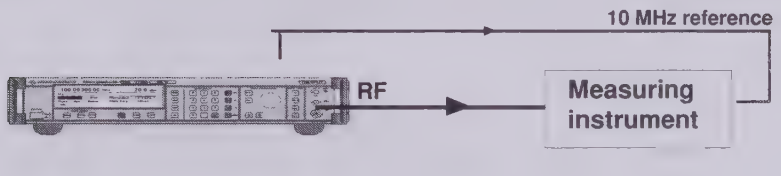
Standard Test Setup

Test setup 1:

Test equipment

- Modulation analyzer
  (Table Measuring equipment and accessories, item 10)
  or
- Spectrum analyzer
  (Table Measuring equipment and accessories, item 2)
  or
- Frequency counter
  (Table Measuring equipment and accessories, item 1)

Test setup



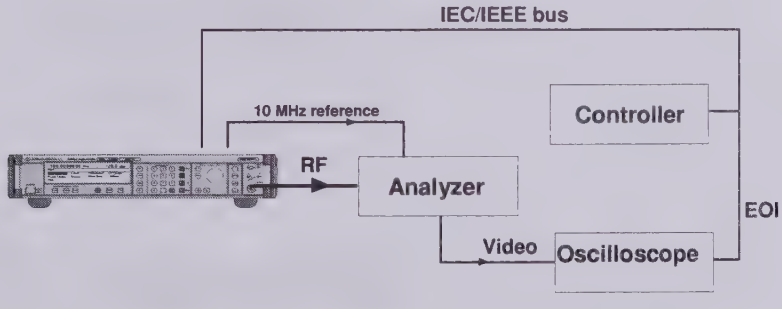
Test Setup for Setting Time

Test setup 2:

Test equipment

- Spectrum analyzer with video output (Table Measuring equipment and accessories, item 2)
- Storage oscilloscope (Table Measuring equipment and accessories, item 4)
- Controller (Table Measuring equipment and accessories, item 8)

Test setup



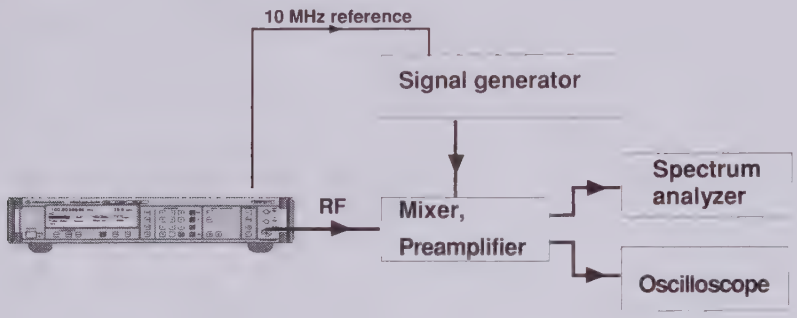
Test Setup for SSB Phase Noise and Broadband Noise

Test setup 3:

Test equipment

- Second signal generator
  (Table Measuring equipment and accessories, item 3)
- Phase noise test set, consisting of
- Mixer with lowpass and preamplifier
  (Table Measuring equipment and accessories, item 5)
- Oscilloscope (Table Measuring equipment and accessories, item 4)
- Spectrum analyzer
  (Table Measuring equipment and accessories, item 2)

Test setup



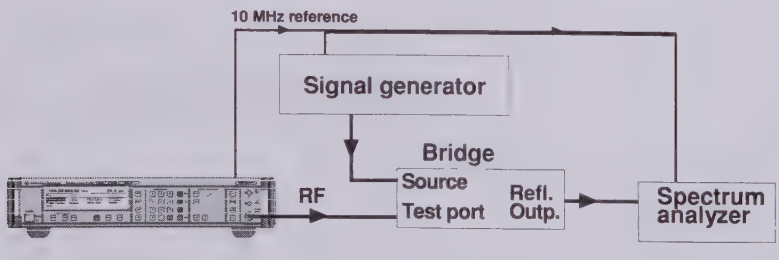
Test Setup for Output Reflection Factor

Test setup 4:

Test equipment

- SWR bridge
  (Table Measuring equipment and accessories, item 9)
- Second signal generator
  (Table Measuring equipment and accessories, item 3)
- Spectrum analyzer
  (Table Measuring equipment and accessories, item 2)

Test setup



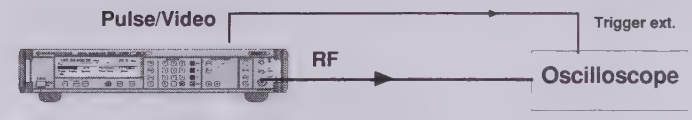
Note: *The test port of the bridge is screwed to the EUT. The INPUT connector of the directional coupler is screwed to the EUT. The second signal generator is connected to the output and the analyzer to the decoupling output (-13 dB).*

Test setup 5:

Test equipment

- Storage oscilloscope
  (Table Measuring equipment and accessories, item 4)

Test setup



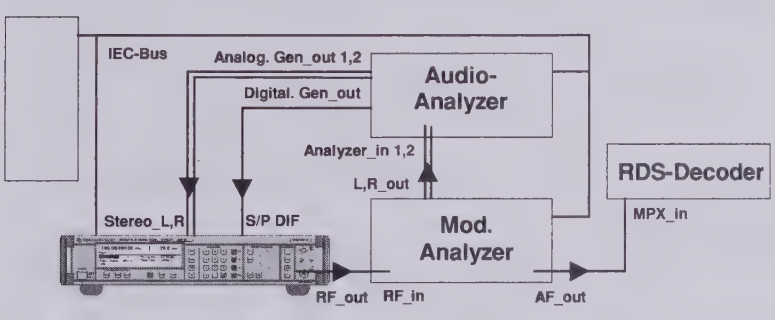
Note: *Since the oscilloscope has a high-impedance input, the BNC line at the oscilloscope has to be terminated with 50 Ω via a T piece.*

Test setup 6:

Test equipment

- Modulation analyzer
  (Table Measuring equipment and accessories, item 10)
- Audio analyzer
  (Table Measuring equipment and accessories, item 14)
- RDS decoder
  (Table Measuring equipment and accessories, item 15)

Test setup



Test Procedure

Display and Keyboard

Testing Display

➢ Switch on unit.

⇨ The basic menu is displayed after a few seconds.

➢ Change setting in menu item UTILITIES DISPLAY CONTRAST using the rotary knob

⇨ The contrast changes from dark to bright.

Testing Keyboard

➢ Press keys and check response on display.

Frequency

Frequency Setting

Test setup

➢ Test setup 1 with frequency counter

Settings on SML

- UTILITIES REF OSC SOURCE EXTERN
- LEVEL: 0 dBm
- FREQ: *Test frequency, frequency accuracy*
  Test frequencies, frequency accuracy: 60 MHz, 100 MHz, 250 MHz, 600 MHz, 1000 MHz

Measurement

➢ The measured values should be indicated at the accuracy allowed by the resolution of the frequency counter.

Setting Time

Test setup

➢ Test setup 2

Test method

The spectrum analyzer is operated as a slope detector with a 0 Hz span. A controller transmits the start and target frequency via the IEC/IEEE bus. The storage oscilloscope is connected to the video output of the analyzer and triggered on the EOI line of the IEC/IEEE bus by the positive edge. If the controller switches from start to end frequency, the settling process can be observed on the storage oscilloscope.

Preparation of measurement

➢ Synchronize reference frequencies of SML and analyzer.

➢ Make IEC/IEEE-bus and RF connections.

➢ Connect storage oscilloscope to video output of analyzer.

➢ Apply trigger line to EOI line (pin 5) of IEC/IEEE bus.

➢ Settings on storage oscilloscope
- Time base > settling time to be measured,
- Sensitivity according to video output of analyzer,
- Triggering of calibration is free-running.

➢ Settings on spectrum analyzer
- Reference level -5 dBm,
- Amplitude scale 1 dB/div,
- Resolution bandwidth 10 kHz,
- Video bandwidth 100 kHz,
- Span 30 kHz.

➢ Reduce center frequency of analyzer starting from the end frequency so that the filter edge is displayed at the center of the screen.

➢ Reduce span to 0 Hz and calibrate frequency scale on (free-running) oscilloscope by 100 Hz steps on SML.

Settings on SML

- LEVEL 0 dBm
- UTILITIES REF OSC SOURCE EXTERN

Measurement

➢ Setting on storage oscilloscope see above
- Now external triggering on positive edge at 1.5 V.

➢ First send start and then end frequency from controller.

⇨ The settling characteristic is shown on the display of the externally triggered oscilloscope.

➢ Repeat measurement by interchanging the start and end frequencies.

The following settings are to be measured in both directions:

Start frequencies	Target frequencies
303 MHz	1075 MHz
75 MHz	810 MHz

Quick Basic program for controller:

```
CLS
iecadresse% = 28                                    IEC/IEEE-bus address of SML (28)
CALL IBFIND("DEV1", generator%)                     Open DEV1 and get access number
CALL IBPAD(generator%, iecadresse%)                 Set IEC/IEEE-bus address of DEV1 to 28
iecterm% = &HA '                                    Set EOS to LINE FEED
CALL IBEOS(generator%, iecterm% + &H800)
CALL IBWRT(generator%, "POW 0dBm")
DO
  INPUT "Start frequency in MHz";F1$
  INPUT "Stop frequency in MHz";F2$
  DO
   CALL IBWRT(generator%, "FREQ" + F1$ + "MHz")
   PRINT "Frequency:";F1$; "MHz"
   DO '                                             Wait for key
     kbd$ = INKEY$
   LOOP UNTIL LEN(kbd$)
   SWAP F1$, F2$
  LOOP UNTIL kbd$ = CHR$(27) '                      Quit with ESCAPE
  INPUT "Repetition (y/n)"; w$
LOOP UNTIL NOT UCASE$(w$) = "J"
END
```

Reference Frequency

Note *Warm up SML for at least 2 hours prior to measurement.*

Test equipment — Frequency counter (Section "Measuring Equipment and Accessories", item 1)

Test setup — ➢ Connect frequency counter to output REF EXT at rear of SML.

Measurement — ➢ Measure frequency.

Evaluation — The frequency error should not exceed the sum of errors made up of the frequency error in the nominal temperature range and ageing.

Spectral Purity

Harmonic Suppression

Test setup
➢ Test setup 1 with spectrum analyzer

Settings on SML
- LEVEL 10 dBm (or max. level according to data sheet)
- FREQ *test frequency of harmonics*
  Test frequency of harmonics: 9 kHz, 5 MHz, 76 MHz, 100 MHz, 151 MHz, 200 MHz, 255 MHz, 400 MHz, 605 MHz, 700 MHz, 900 MHz, 1100 MHz

Setting on spectrum analyzer
- Reference level= test level+10 dB, 10 dB/div
- Span 300 kHz, resolution 30 kHz

Measurement
➢ First measure the fundamental level as reference, then search signals at twice or three times the carrier frequency. Make sure that spectrum analyzer is not overdriven.

Evaluation
The harmonic suppression is the level difference between the measured harmonic and the SML output signal (in dBc, with reference to the carrier).

Nonharmonic Suppression

Test setup
➢ Test setup 1 with spectrum analyzer

Settings on SML
- UTILITIES REF OSC SOURCE EXTERN
- LEVEL 10 dBm
- FREQ *test frequency of nonharmonics*
  Test frequencies of nonharmonics: 899.052 MHz, 1080.003 MHz, 1086.2 MHz, 1086.9535 MHz, 1098.956 MHz, 1095.002 MHz, 979.713 MHz, 927.2776 MHz, 1022.438 MHz, 987.315 MHz, 980.729 MHz

Setting on spectrum analyzer
- Reference level= test level + 3 dB, 10 dB/div
- Start frequency = test frequency – 5 kHz, span 100 kHz
- Resolution 1 kHz
- Switch on average: 5 samples

Measurement
➢ First measure level of fundamental as reference. Then measure level of nonharmonics, if any.

Evaluation
The nonharmonic suppression is the level difference between the measured nonharmonic and the SML output signal (in dBc with reference to the carrier).

Note: *The values for setting the spectrum analyzer are reference values and depend on the analyzer used. The required settings have to be verified prior to each measurement.*

SSB Phase Noise

Test setup

➢ Test setup 3

Settings on SML

- UTILITIES. REF OSC SOURCE EXTERN
- LEVEL 0 dBm (or level to mixer specification)
- FREQUENCY 1 GHz (or any test frequency)

Test method

The two signal generators are set to the test frequency and synchronized with a phase shift of 90° (phase quadrature). The RF carrier is suppressed by mixing to 0 Hz. Due to the phase quadrature the mixer supplies a voltage that corresponds to the phase difference between the input signals. The phase difference is measured by the spectrum analyzer and can be converted into SSB phase noise.

Measurement

➢ Set levels of two signal generators according to the specifications of the used mixer.

➢ For calibration purposes reduce level of EUT by 40 dB and detune a signal generator by 20 kHz. Test signal for harmonics, the 2nd and 3rd harmonic should be more than 30 dB below the fundamental. Measure and note reference value at 20 kHz on analyzer.

➢ Revoke detuning and establish phase quadrature. To do this, set level of EUT again and detune phase offset on auxiliary generator. Observe mixer output voltage on oscilloscope until the voltage becomes 0.

➢ Read noise voltage on analyzer that is normalized to a bandwidth of 1 Hz (noise level).

Evaluation

➢ Form the difference to the reference level and add 6 dB for the measured (correlated) second sideband and 40 dB to level switching. If the noise level of the second signal generator is not at least 10 dB better than that of the EUT, the noise component of the reference transmitter too has to be determined and calculated.

⇨ The value found gives the correct noise level.

Example: *The reference level is to be measured at 12 dBm. At 20 kHz a noise level of -78 dBm (1 Hz) is determined. The difference is 90 dB. In addition to the correction for the second sideband (6 dB) and the level switching (40 dB) a noise level of -136 dB or of -136 dBc (dB with reference to the carrier power) is obtained. If two identical signal generators are used, the result has to be reduced by 3 dB for the (uncorrelated) noise power of the reference transmitter.*

The final result is then -139 dBc.

Broadband Noise

Test setup

➢ Test assembly 3

Settings on SML

- UTILITIES REF OSC SOURCE EXTERN
- LEVEL 0 dBm (or level according to mixer specification)
- FREQUENCY 1 GHz (or any test frequency)

Test method

Calibration is in the same way as with SSB phase noise. To perform the measurement, the signal generators are detuned so that the difference frequency falls in the stopband range of the lowpass filter for sufficient suppression of the measurement. Then measure a section of the sum of broadband noise contributions imaged at the zero line on the spectrum analyzer. The noise spaced at the difference frequency now is at 0 Hz on the spectrum analyzer. The measurement is performed at the calibration frequency (20 kHz). This frequency should be negligibly small compared to the difference frequency. The measured power must be divided by half due to the imaging at the zero line.

Measurement

➢ Calibration is in the same way as with SSB phase noise.

➢ Detune to offset frequency (2 MHz).

➢ Set level of the EUT again and read noise power per Hz on analyzer at a center frequency of 20 kHz.

Evaluation

➢ Form the difference to the reference level and add 43 dB for the level switching and the image-frequency band.

➢ The measured value is the sum of the noise power of the two signal generators. If the noise level of the second signal generator is not at least 10 dB better than that of the EUT, the noise component of the reference transmitter too has to be determined. Since the reference transmitter is at the LO input, only the phase noise component has to be considered. It is 3 dB lower than the whole broadband noise (AM component is suppressed). With two identical transmitters the correction is thus another 1.8 dB. Note that the reference transmitter has a higher level which further improves the noise level.

⇨ The value found gives the correct noise level.

Residual FM

Test setup	➢ Test setup 1 with modulation analyzer
Settings on SML	- LEVEL 0 dBm - FREQ 1 GHz
Setting on modulation analyzer	- Demodulation: FM - Detector: RMS - Filter: ITU-T (CCIT) or 20 Hz to 23 kHz
Measurement	➢ Read frequency deviation on modulation analyzer on both filters.

Residual AM

Test setup	➢ Connect modulation analyzer to RF output of SML.
Settings on SML	- LEVEL 0 dBm - FREQ 1 GHz
Setting on modulation analyzer	- Demodulation: AM - Detector: RMS - Filter: 20 Hz to 23 kHz
Measurement	➢ Read residual AM on modulation analyzer.

Level

Level Frequency Response and Linearity

Test equipment

- Power meter (Table Measuring equipment and accessories, item 6)
- Precision attenuator (Table Measuring equipment and accessories, item 7)
- Spectrum analyzer (Table Measuring equipment and accessories, item 2)
- Low-noise preamplifier (Table Measuring equipment and accessories, item 13)

Test method for level in measurement range of power meter (up to approx. - 20 dBm)

Test setup

➢ Connect power meter to RF output connector.

Settings on SML

- FREQ *Test frequency level accuracy*
  Test frequencies: 9 kHz, 5 MHz, 5.1 MHz, 76 MHz, 77 MHz, 151 MHz, 255 MHz, 302 MHz, 605 MHz, 606 MHz, 725 MHz, 970 MHz, 1100 MHz
- LEVEL *Test level 1 level accuracy*
  Test level 1: 13 dBm, 10 dBm, 5.1 dBm, 5 dBm, 0 dBm, -5 dBm, -10 dBm, -15 dBm, -19.9 dBm, -20.0 dBm

Settings on power meter

- Carry out a ZEROING prior to level measurements.
- The level on SML is switched off with RF OFF.

Measurement

➢ Measure level at test frequencies.

⇨ The frequency response is the difference between the highest and lowest measured value.

⇨ The level error is the deviation from the set value.

Measurement procedure for low levels (>-115 dBm)

***Caution**: The precondition for correct measurement is that the used components are wholly RF-shielded.*

Test method

Levels below the measurement range of the power meter can be measured by a comparison measurement using a precision attenuator and a sensitive test receiver or spectrum analyzer. The reference is formed by a level measurement for example at 10 dBm by means of the power meter.

Test setup

➢ Connect a precision attenuator to the RF connector of SML. Connect the attenuator output to a spectrum analyzer via RF-leakage-proof test cables.

➢ Connect 10 MHz references with each other.

Settings on SML

- FREQ *Test frequency Level accuracy*
  Test frequencies: 9 kHz, 5 MHz, 5.1 MHz, 76 MHz, 77 MHz, 151 MHz, 255 MHz, 302 MHz, 605 MHz, 606 MHz, 725 MHz, 970 MHz, 1100 MHz
- LEVEL 10 dBm
- UTILITIES REF OSC SOURCE EXT

Settings on test receiver or analyzer
- Center frequency = test frequency
- Span = 0 Hz

Settings on precision attenuator
- Attenuation = 125 dB

Measurement

➢ Read level on test receiver or analyzer and note down as reference value. It should be at 10 dBm -125 dB. Select measurement bandwidth to small value to obtain an accurate reading.

➢ Now repeat measurement at the settings given in Table 10-1 "Test level 2 Level accuracy".
SML01: reference level = 10 dBm

⇨ The deviation from the reference value shown on analyzer display is the level error.

Measurement at levels <-115 dBm

Caution: *The precondition for correct measurement is that the used components are wholly RF-shielded.*

Test setup

➢ Switch a low-noise preamplifier between SML and precision attenuator.

Measurement

➢ Perform a calibration at a measured level.

⇨ It is thus possible to measure levels down to the lower limit of SML.

Table 10-1 Test level2 Level accuracy

Level on SML	Attenuation of attenuator
Reference level	125 dB
Reference level -5 dB	120 dB
Reference level -10 dB	115 dB
Reference level -20 dB	105 dB
Reference level -40 dB	85 dB
Reference level -60 dB	65 dB
Reference level -80 dB	45 dB
Reference level -100 dB	25 dB
Reference level -120 dB	5 dB
Reference level -125 dB	0 dB

Output Reflection Coefficient

Test setup

Test setup 4 (output reflection coefficient).

Measurement procedure

Since the SWR of a source is to be measured, a purely passive measurement using the SWR bridge is only possible at levels for which the SWR is determined by the output impedance of the electronic attenuator.

For higher levels, the effect of level control has to be considered. This is done by means of an auxiliary generator which sends a wave with a slightly offset carrier frequency (difference frequency within the level bandwidth of level control) to the EUT. The carrier frequency is superimposed by the outgoing wave. Given an ideal internal impedance, the outgoing wave of the EUT alone flows back to the SWR bridge. At any other internal impedance, there is a superposition of the two components which, due to the frequency offset, results in a beat. The SWR can be concluded from the amplitude ratio of this beat.

Settings on SML

- LEVEL 5.1 dBm, 0.1 dBm
- FREQ test frequency SWR
  Test frequency: 100 MHz, 500 MHz, 800 MHz, 1 GHz, 1.1 GHz

Settings on spectrum analyzer

- Center frequency = test frequency
- Span = 0 Hz
- Reference level= test level
- Resolution and video bandwidth = 10 kHz
- Linear level scale
- Sweep time = 30 ms

Settings on 2nd signal generator

- Frequency = test frequency – 100 Hz
- first RF OFF

Measurement

➢ Now bring displayed line to center of screen by changing the reference level and note down level as reference level.

➢ Unscrew SWR bridge from SML and increase level on second signal generator so that the reference level is again measured on the analyzer.

➢ Screw SWR bridge or directional coupler again to SML.

⇨ A more or less undulating line can now be seen on the spectrum analyzer. This line represents the SWR of SML.

Calculate SWR from the maximum and minimum voltage according to the following equation:

$SWR = u_{max}/u_{min}$.

Passive measurement of SWR at output levels of SML below -25 dBm

Settings on SML
- LEVEL –25 dBm, -40 dBm
- FREQ far from test frequency (>10 MHz)

Settings on 2nd signal generator
- Frequency = test frequency
- Level = 10 dBm

Measurement
- ➢ Unscrew SWR bridge from EUT and note down level measured on analyzer as reference value.
- ➢ Screw on SWR bridge or directional coupler again and determine new level on analyzer.
  - ⇨ The test level/reference level voltage ratio is the output reflection coefficient r of the EUT.
- ➢ Determine the standing wave ratio (SWR) according to the following formula

  SWR = (1+r)/(1-r).

Setting Time

Test setup

Test setup 2 (setting time)

Test method

The spectrum analyzer is operated as a fast level meter at a span of 0 Hz. A controller transmits the start and end frequency via IEC/IEEE bus. The storage oscilloscope is connected to the video output of the analyzer and triggered on the EOI line of the IEC/IEEE bus by the positive edge. If the controller switches from start to end frequency, the settling process can be seen on the storage oscilloscope.

Preparing measurement
- ➢ Synchronize reference frequencies of SML and analyzer.
- ➢ Make IEC/IEEE-bus and RF connections.
- ➢ Connect storage oscilloscope to video output of analyzer.
- ➢ Apply trigger line to EOI line (pin 5) of IEC/IEEE bus.
- ➢ Settings on storage oscilloscope
  - Timebase 5 ms/div,
  - Sensitivity according to video output of analyzer.
- ➢ Settings on spectrum analyzer
  - Reference level 10 dBm,
  - Amplitude scale 10 dB/div,
  - Resolution bandwidth 300 kHz,
  - Video bandwidth 300 kHz,
  - Span 0 Hz.

Settings on SML
- FREQ 1 GHz

Measurement

- ➢ Setting on storage oscilloscope
  - External triggering on positive edge at 1.5 V.
- ➢ First send start and then end level from controller.
  - ⇨ The level characteristic from the moment of triggering is displayed on the externally triggered oscilloscope.
- ➢ Repeat measurement by interchanging the start and end levels.
- ➢ Measure the following settings in both directions.

Setting	Start level	End level	Remark
CW	–140 dBm	13 dBm	With electric attenuator, only to target level
CW	-24.9 dBm	13 dBm	With electric attenuator
AM 30%	2.1 dBm	10 dBm	Without electric attenuator

Quick Basic program for controller

```
CLS
iecadresse% = 28                                    IEC/IEEE-bus address of SML (28)
CALL IBFIND("DEV1", generator%)                     Open DEV1 and get access number
CALL IBPAD(generator%, iecadresse%)                 Set IEC/IEEE-bus address of DEV1 to 28
iecterm% = &HA '                                    Set EOS to LINE FEED
CALL IBEOS(generator%, iecterm% + &H800)
CALL IBWRT(generator%, "FREQ 1GHz")
DO
  INPUT "Start level in dBm";P1$
  INPUT "Stop level in dBm";P2$
  DO
   CALL IBWRT(generator%, "POW" + P1$ + "dBm")
   PRINT "Level: ";P1$; "dBm"
   DO '                                             Wait for key
     kbd$ = INKEY$
   LOOP UNTIL LEN(kbd$)
   SWAP P1$, P2$
  LOOP UNTIL kbd$ = CHR$(27) '                      Quit with ESCAPE
  INPUT "Repetition (y/n)"; w$
LOOP UNTIL NOT UCASE$(w$) = "J"
END
```

Non-interrupting Level Setting (ATTENUATOR FIXED)

Test setup

Test setup1 with spectrum analyzer

Settings on SML

- FREQ *test frequencies ATT-FIX*
  Test frequencies: 9 kHz, 5.1 MHz, 1100 MHz
- LEVEL 5.1 dBm
- LEVEL LEVEL ATTENUATOR MODE FIXED

Measurement

➢ Note down level read on analyzer as reference level or set delta marker for relative measurement to 0 dB.

➢ Now reduce level in steps of 5 dB on SML.

⇨ Do not exceed the following values.

Reduction in dB ATT FIXED	Tolerance in dB
5	0.4
10	0.6
15	1.2
20	3.0

Overvoltage Protection

Test equipment

Sinewave generator (Table Measuring equipment and accessories, item 11)

Test setup

➢ Connect sinewave generator to RF output of SML.

Settings on SML

- LEVEL -140 dBm
- FREQ 100 MHz

Settings on sinewave generator

- Frequency = 20 kHz
- Output impedance = 50 Ω
- Level = 1 V
- Level offset = ±5 V

Measurement

➢ Increase output level of sinewave generator up to 10 V max. (EMF)

⇨ At a voltage (offset+EMF/2) >4 V and < 7.5 V the overvoltage protection should respond at both polarities.

Internal Modulation Generator

Note: *The setting time is a pure computing time and does not have to be measured.*

Level Accuracy

Test equipment: AC voltmeter (Table Measuring equipment and accessories, item 12)

Test setup:
➢ Connect AC voltmeter to LF connector of SML.

Settings on SML:
- LF OUTPUT STATE ON
- LF OUTPUT LFGen 1 kHz
- LF OUTPUT VOLTAGE *test level LFGen*
  Test level: 3 mV, 10 mV, 100 mV, 1 V, 4 V

Measurement:
➢ Measure output level

Frequency Response

Test equipment: AC voltmeter (Table Measuring equipment and accessories, item 12)

Test setup:
➢ Connect AC voltmeter to LF connector of SML.

Settings on SML:
- LF OUTPUT STATE ON
- LF OUTPUT VOLTAGE 1 V and 4 V
- LF OUTPUT LFGen *test frequencies LFGen*
  Test frequency: 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, 200 kHz to 500 kHz

Measurement:
➢ Measure frequency response.
⇨ The frequency response is the difference between the highest and lowest level.

Frequency Accuracy and Distortion

Test equipment: Modulation analyzer (synchronized with SML)

Test setup:
- ➢ Connect LF voltmeter input of modulation analyzer to LF connector of SML.
- ➢ Connect spectrum analyzer at frequencies >100 kHz.

Settings on SML:
- LF OUTPUT STATE ON
- LF OUTPUT VOLTAGE 1 V and 4 V
- LF OUTPUT LFGen *test frequencies LFGen*
  For frequency accuracy: 100 Hz, 33.33 kHz, 1 MHz
  For distortion: 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz

Measurement:
- ➢ Read actual frequency on audio or spectrum analyzer.
- ➢ Read distortion on audio analyzer.

Amplitude Modulation

AM Deviation Setting

Test assembly: Test setup1 with modulation analyzer

Settings on SML:
- LEVEL 0 dBm
- FREQ test frequencies of AM deviation
  Test frequencies: 100 kHz, 1 MHz, 5 MHz, 5.1 MHz, 76 MHz, 100 MHz, 200 MHz, 500 MHz, 800 MHz, 1100 MHz
- MODULATION AM AM DEPTH test deviation of AM deviation
  Test deviation of AM deviation: 1%, 30%, 80%
  AM SOURCE LFGen
  LFGenFreq 1 kHz

Measurement:
- ➢ Read modulation depth on modulation analyzer.

AM Frequency Response

Test assembly: Test setup1 with modulation analyzer

Settings on SML:
- LEVEL 0 dBm
- FREQ *test frequencies of AM frequency response*
  Test frequencies: 350 kHz, 5,1 MHz, 1100 MHz
- MODULATION AM AM DEPTH 60%
  AM SOURCE: LFGen
  LFGenFreq 10 Hz to 50 kHz

Measurement:
- ➢ Determine modulation frequency response by varying the LF generator frequency.
- ➢ Repeat measurement with external sinewave generator with setting MODULATION AM AMSOURCE EXT. (Setting on sinewave generator: 1 Vpeak)
  - ⇨ The modulation frequency response is the difference between the highest and lowest modulation depth.

AM Distortion

Test assembly: Test setup1 with modulation analyzer

Settings on SML:
- LEVEL 2.1 dBm and 8 dBm
- FREQ *test frequencies of AM distortion*
  Test frequencies: 100 kHz, 5 MHz, 5.1 MHz, 76 MHz, 100 MHz, 200 MHz, 500 MHz, 800 MHz, 1100 MHz
- MODULATION AM AM DEPTH 30%, 80%
  AM SOURCE LFGen
  LFGenFreq 1 kHz

Measurement:
➢ Read distortion on modulation analyzer.

Residual PhiM at AM

Test assembly:
➢ Test setup 1 with modulation analyzer

Settings on SML:
- LEVEL 8 dBm
- FREQ *test frequencies of residual PhiM*
  Test frequencies: 100 kHz, 5 MHz, 5.1 MHz, 76 MHz, 100 MHz, 200 MHz, 500 MHz, 800 MHz, 1100 MHz
- MODULATION AM AM DEPTH 30%,
  AM SOURCE LFGen
  LFGenFreq 1 kHz

Measurement:
➢ Measure the phase modulation obtained with 23-kHz lowpass filter and peak weighting on modulation analyzer.

Frequency Modulation

FM Deviation Setting

Test setup:
➢ Test setup 1 with modulation analyzer

Settings on SML:
- LEVEL 0 dBm
- FREQ 1 GHz
- MODULATION FM FM DEVIATION 100 kHz
  FM SOURCE LFGen
  LFGenFreq 1 kHz

Setting on modulation analyzer:
Demodulation: FM
Detector: peak detector
Filter: 20 Hz to 23 kHz

Measurement:
➢ Read frequency deviation on modulation analyzer

Note: *SML has a purely digital deviation control so that it is sufficient to check its functionality at one deviation setting and one frequency only.*

FM Frequency Response

Test setup
➢ Test setup 1 with modulation analyzer

Settings on SML
- LEVEL 0 dBm
- FREQ 1 GHz
- MODULATION FM FM DEVIATION 100 kHz
  FM SOURCE LFGen

Setting on modulation analyzer
Demodulation: FM
Detector: peak detector

Measurement
➢ The modulation frequency response is determined by varying the generator frequency of the internal LF generator in the FM menu from 10 Hz to 100 kHz. It is obtained from the difference between the lowest and highest measured deviation.

Note:
Since there is no difference between the FM and PHiM frequency response, the measurement of the wide FM loop can be omitted. The measurement of the wide PhiM loop can be performed on the spectrum analyzer and is thus much more easier. The modulation analyzer only has a bandwidth of approx. 200 kHz.

FM Distortion

Test setup
Test setup 1 with modulation analyzer

Settings on SML
- LEVEL 0 dBm
- FREQ *test frequency of FM distortion*
  Test frequencies: 605.5 MHz, 650 MHz, 700 MHz, 750 MHz, 807 MHz
- MODULATION:FM:FM DEVIATION 500 kHz
  FM SOURCE: LFGen
  LFGenFreq 1 kHz

Setting on modulation analyzer
Demodulation: FM
Detector: peak detector
Audio: distortion

Measurement
➢ Read distortion on modulation analyzer.

Residual AM at FM

Test setup
➢ Test setup 1 with modulation analyzer

Settings on SML
- LEVEL 0 dBm
- MODULATION FM FM DEVIATION 40 kHz
  FM SOURCE LFGen
  LFGenFreq 1 kHz
- FREQUENCY: *test frequency of residual AM*
  Test frequencies: 10 MHz, 75 MHz, 100 MHz, 300 MHz, 500 MHz, 800 MHz, 1100 MHz

Setting on modulation analyzer
Demodulation: AM
Detector: RMS
Lowpass filter: 23 kHz

Measurement
➢ Set test frequencies on SML and read residual AM on modulation analyzer.

Carrier Frequency Error at FMDC

Test setup
➢ Test setup 1 with frequency counter

Settings on SML
- UTILITIES CALIB FM OFFSET
- UTILITIES REF OSC SOURCE EXTERN
- LEVEL 0 dBm
- MODULATION FM FM DEVIATION 100 kHz
  FM SOURCE EXT
  EXT COUPLING DC
- FREQ *test frequency FMDC*
  Test frequencies: 630 MHz, 680.5 MHz, 667.6 MHz, 674.7 MHz, 669 MHz, 672 MHz, 617.6 MHz, 641.2 MHz, 640.2 MHz, 641.1 MHz

Measurement
➢ Read frequency on frequency counter. The difference to the set RF frequency on SML is the center frequency error.

Note: *This value is not specified but is normally less than 0.1% of the set deviation and thus less than 100 Hz at a set deviation of 100 kHz.*

Crosstalk Attenuation at FM Stereo

Test setup

➢ Test setup 1 with modulation analyzer

➢ Connect connector AF1 of stereocoder to input MOD on SML

Settings on SML

- LEVEL 0 dBm
- MODULATION FM FM DEVIATION 46.5 kHz
  FM SOURCE EXT
  EXT COUPLING DC
- FREQ test frequency stereo
  Test frequencies: 87 MHz, 98 MHz, 108 MHz

Setting on modulation analyzer

Switch on stereo signal 1 kHz on stereocoder, set level of useful signal to peak deviation of 40 kHz and level of pilot tone to 6.5 kHz peak deviation.
Demodulation: FM STEREO
CHANNEL: L or R
DETECTOR RMS
FILTER: 10 Hz to 100 kHz
Deviation measurement is relative

Measurement

➢ On stereocoder switch on left channel and perform relative measurement. Then switch to right channel on demodulator and read crosstalk attenuation.
Then perform the same measurement with the right channel.

Distortion FM Stereo

Test setup

➢ See Crosstalk Attenuation at FM Stereo

Settings on SML

- See Crosstalk Attenuation at FM Stereo

Setting on modulation analyzer

- Stereo signal like for crosstalk attenuation measurement
- Demodulation: FM STEREO
- CHANNEL: L or R
- DETECTOR RMS
- FILTER: 10 Hz to 100 kHz
- AUDIO: switch on distortion

Measurement

➢ Read distortion on modulation analyzer

➢ Perform measurement for left and right channel.

S/N Ratio of FM Stereo

Test setup
➢ See Crosstalk Attenuation at FM Stereo

Settings on SML
- See Crosstalk Attenuation at FM Stereo

Setting on modulation analyzer
- Stereo signal like for crosstalk attenuation measurement
- Demodulation: FM STEREO
- CHANNEL: L or R
- FILTER: CCIR WT or UNWT
- DETECTOR RMS
- Deviation measurement relative
- DEEMPHASIS 50 µs

Measurement
➢ On stereocoder switch on left or right channel and perform relative measurement. Then switch off useful signal on stereocoder and read S/N ratio. Carry out measurement for both filters (weighted and unweighted). Then switch on right channel and repeat the same measurement.

Phase Modulation

PhiM Deviation Setting

Test setup
➢ Test setup 1 with modulation analyzer

Settings on SML
- LEVEL 0 dBm
- FREQ 1 GHz
- MODULATION PhiM PHiM DEVIATION 5 rad
  PhiM SOURCE LFGen
  LFGenFreq 1 kHz

Setting on modulation analyzer
- Demodulation: PhiM
- Detector: peak detector
- Filter: 20 Hz to 23 kHz

Measurement
➢ Read phase deviation on modulation analyzer

Note: *SML has a purely digital deviation control so that it is sufficient to check its functionality at one deviation setting and one frequency only.*

PhiM Frequency Response

Test setup
➢ Test setup 1 with spectrum analyzer

Settings on SML
- UTILITIES REF OSC SOURCE EXT
- LEVEL 0 dBm
- FREQ 1 GHz
- MODULATION PhiM PHiM DEVIATION 0.5 rad
  PHiM SOURCE INT
  PHiM BANDWIDTH STANDARD/WIDE

Setting on spectrum analyzer
- Start frequency 1 GHz
- Span 500 kHz at wide loop/100 kHz at standard loop
- LEVEL RANGE 20 dB
- RES BW 10 kHz/3 kHz
- Switch on MAX HOLD function

Measurement
➢ By varying the generator frequency of the LF generator from 1 kHz to 100 kHz or with wide loop of up to 500 kHz, the PHiM frequency response appears on the spectrum analyzer. The difference measurement between the maximum and minimum point of the characteristic is the modulation frequency response. The carrier frequency at the left margin of the spectrum analyzer is not considered.

Note: *Since there is no difference between the FM and PHiM frequency response, the standard PhiM loop can be measured analog to the FM frequency response.*

PhiM Distortion

Test setup
➢ Test setup 1 with modulation analyzer

Settings on SML
- LEVEL 0 dBm
- FREQ 1 GHz
- MODULATION PhiM PHiM DEVIATION 5 rad
  FM SOURCE LFGen
  LFGenFreq 1 kHz

Setting on modulation analyzer
- Demodulation: PHiM
- Detector: peak detector
- Audio: distortion

Measurement
➢ Read distortion on modulation analyzer

Pulse Modulation (Option SML-B3)

On/Off Ratio

Test setup
➢ Test setup 1 with spectrum analyzer

Settings on SML
- LEVEL 10 dBm
- FREQ 1 GHz
- MODULATION PULSE PULSE SOURCE OFF

Setting on spectrum analyzer
- Center 1 GHz
- Span 20 kHz
- Reference level 10 dBm
- Marker peak

Measurement
➢ Note down ON level on spectrum analyzer.

Setting on SML
- MODULATION PULSE PULSE SOURCE EXT
- Make sure that pulse input is not connected.

Setting on spectrum analyzer
- Reference level -50 dBm
- Switch on average: 5 samples
- Peak marker

Measurement
➢ Note down OFF level on spectrum analyzer.

The on/off ratio is calculated from ON and OFF levels.

Dynamic Characteristics

Rise/Fall Time

Test setup
➢ Test setup 5

Settings on SML
- LEVEL 10 dBm
- FREQ 53 MHz
- MODULATION PULSE PULSE SOURCE PULSE GEN
  PULSE PERIOD 0.100 us
  PULSE WIDTH 0.060 us
- PULSE OUTPUT PULSE SOURCE VIDEO

Setting on oscilloscope
- Trigger EXT
- Probe 1x
- X: 5 ns/div
- Y: 5 V/div
- Switch-off delay approx. 1 sec. (if possible)

Measurement
- Measure rise/fall time of 10% to 90% of pulse bursts

Video Crosstalk

Test setup
- ➢ Test setup 5

Settings on SM
- FREQ 1 GHz
- LEVEL 10 dBm
- ATT FIXED
- LEVEL -100 dBm
- MODULATION PULSE PULSE SOURCE PULSE GEN
- PULSE PERIOD 0.100 us
- PULSE WIDTH 0.060 us
- PULSE OUTPUT PULSE SOURCE VIDEO

Setting on oscilloscope
- Trigger EXT
- Probe 1x
- X: 10 ns/div
- Y: 10 mV/div
- Switch-off delay approx. 1 sec. (if possible)

Measurement
- ➢ Measure V_{pp} of video

Stereo Modulation (Option SML-B5)

Frequency Response

Test setup
➢ Test setup 6

Settings on SMV03
- PRESET
- FREQ 100MHz
- LEVEL 0 dBm
- MODULATION STEREO SOURCE LFGEN (or EXT L/R) MODE L (or MODE R)

Settings on UPL
- GEN INSTRUMENT ANALOG
- Channel 1 or 2
- Output bal
- Impedance 10Ohm
- GEN FUNCTION Sine
- GEN FREQUENCY 1kHz
- GEN Voltage 0.707V

Settings on FMB
- DEMODULATOR FM-STEREO
- CHANNEL L (or R)
- RELATIVE

Measurement
➢ First set LF generator of SMV03 (or UPL) to 500Hz and measure the reference level (MEAS-REF), then measure the frequency response by varying the frequency of the LF generator from 20Hz to 15kHz. Measure the frequency response for Internal L, Internal R, External L and External R. Max. values see datasheet.

Distortion and Channel Separation

Test setup
Test setup 6

Settings on SMV03
- PRESET
- FREQ test frequency
- LEVEL 0 dBm
- MODULATION STEREO SOURCE EXT L/R, MODE L (bzw. MODE R)

Test frequencies: 10.7MHz, 76MHz, 87MHz, 98MHz, 108MHz
AF = 1kHz.

Settings on UPL
- GEN INSTRUMENT ANALOG
- Channel 1 or 2
- Output bal
- Impedance 10Ohm
- GEN FUNCTION Sine
- GEN FREQUENCY 1kHz
- GEN Voltage 0.707V
- GEN Low Distortion = ON (only with UPL-B1)

Settings on FMB
- DEMODULATOR FM-STEREO
- CHANNEL L (or R)
- NOISE FILTER ON
- RELATIVE
- AUDIO DIST-SINAD

Measurement
- ➢ Channel separation: First measure the level of one channel as a reference, then measure the crosstalk in the unmodulated channel. The difference is the channel separation. Min. value see datasheet.
- ➢ Read off distortion factor at the FMB. Max. value see datasheet.

Signal to Noise Ratio

Test setup: Test setup 6

Settings on SMV03
- PRESET
- FREQ Test frequencies
- LEVEL 0 dBm
- MODULATION STEREO, EXT L,R
- MODE L!=R
- Deviation 67.5kHz (acc. IEC 60315-4)

Test frequencies: 10.7MHz, 66MHz,76MHZ, 98MHz,87MHz, 110MHz

Settings on FMB
- DEMODULATION FM-STEREO
- INTERN
- NOISE FILTER ON
- FILTER: see below
- DETEKTOR: see below
- MAN RANGE dBm
- RANGE 12dBm
- CHANNEL L (or R)

Settings on UPL
- GEN INSTRUMENT ANALOG
- Channel 1 (bzw. 2)
- Output bal
- Impedance 10Ohm
- GEN FUNCTION Sine
- GEN FREQUENCY 1kHz
- GEN Voltage 0.707V

Measurement
- ➢ After selection of the below-mentioned filter/detector combinations the le signal has to be measured separately at all test frequncies. The differenc noise ratio.
- ➢ The following filter/detector combinations have to be used:
  CCIR-Weighted / Quasipeak
  CCIR-Unweighted / RMS
  A-Weighted / RMS
- ➢ Specified values see datasheet.

Audio Deviation, Pilot Tone and RDS Subcarrier

Test setup: Test setup 6

Settings on SMV03:
- PRESET
- FREQ test frequency
- LEVEL 0 dBm
- MODULATION STEREO, Source LFGEN, AF=1kHz
- ARI State ON
- ARI Identification OFF

Test frequencies: 10.7MHz, 66MHz, 76MHz, 87MHz, 98MHz, 110MHz

Settings on FMB:
- DEMODULATOR FM-STEREO
- ABSOLUTE
- DETEKTOR +-PEAK/2
- CHANNEL L, PILOT, MORE CARR 57kHz

Measurement:
➢ Read off the deviations at the FMB.
Audio/pilot tone deviation: Setting accuracy < 2.5%
ARI subcarrier deviaton: Setting accuracy < 6%

Preemphasis

Test setup: Test setup 6

Settings on SMV03:
- PRESET
- FREQ 98MHz
- LEVEL 0 dBm
- MODULATION STEREO, Source internal LFGEN
- MODE L=R
- MPX-Hub 10kHz
- PREEMPHASIS OFF / 50us / 75us

Settings on FMB:
- DEMODULATOR FM-STEREO
- RELATIVE
- UNIT dBm
- DETEKTOR +-PEAK/2
- CHANNEL L

Measurement:
➢ Measure reference level at Preemphasis OFF, AF = 15kHz
➢ Preemphasis 50us: required level = +13.66dB
Preemphasis 75us: required level = +17.07dB
Max. tolerance < 0.5dB

Digital S/P Dif Interface

Test setup: Test setup 6

Settings on SMV03:
- PRESET
- FREQ 98MHz
- LEVEL 0 dBm
- MODULATION STEREO, Source S/P-DIF
- MODE L!=R

Settings on FMB:
- DEMODULATOR FM-STEREO
- ABSOLUTE
- DETEKTOR +-PEAK/2
- CHANNEL L, R

Settings on UPL:
- GEN INSTRUMENT DIGITAL
- Channel 1=2
- Unbal Out AUDIO OUT
- Sample Frequency 32kHz, 44.1kHz, 48kHz
- FUNCTION STEREO SINE
- Freq. Mode FREQ CH1&2
- Volt Mode VOLT CH1&2
- Freq Ch.1 1kHz
- Freq Ch.2 0.5kHz
- Volt Ch.1 0.707 FS
- Volt Ch.2 0.707 FS

Measurement:
➢ Read off the selected audio frequency and the audio deviation at the FMB.
Max. tolerances < 2.5%

RDS Function

Test setup: Test setup 6

Settings on SMV03:
- PRESET
- FREQ 98MHz
- LEVEL 0 dBm
- MODULATION STEREO, Source LFGEN, AF=1kHz
- ARI State ON
- RDS State ON

Settings on FMB:
- DEMODULATOR FM-STEREO
- CHANNEL MPX

Settings on DMDC:
- RDS-Inf1 PI,PS, ...
  RDS-Inf1 CT, PIN

Measurement:
➢ Download the data sets DS1 to DS5 containing data for PI, PS, TP, TA, PTY, DI, MS, CT with the controller
➢ Check ARI Identification OFF, DK, BK, DK+BK. Select area codes A to F and check them with the DMDC
➢ Select RDS data set 1 to 5 and check them with the DMDC
➢ Check the clock (CT) with the DMDC.

Performance Test Report

Table 10-2 Performance test report

ROHDE & SCHWARZ	Performance test report	Signal Generator SML	Stock No.: 1090.3000.__
Model (SML01,02,03):			
Serial number:			
Tested by:			
Date:			
Signature:			

Parameter tested	Contained in	Min. value	Actual value	Max. value	Unit	Tolerance limit
Display and keyboard	Page 10.6	Tested				
Frequency						
Frequency setting	Page 10.6	Tested				
Setting time	Page 10.7			10	ms	
Reference frequency, deviation	Page 10.8					
Spectral purity						
Harmonics at level ≤10 dBm	Page 10.9			-30	dBc	
Nonharmonics CW, df >10 kHz	Page 10.9			-70	dBc	
SSB phase noise 1 GHz at 20 kHz carrier spacing	Page 10.10			-122	dBc/Hz	
Broadband noise 1 GHz at 2 MHz carrier spacing	Page 10.11			-140	dBc/Hz	
Residual FM rms at 1 GHz 0.3 to 3 kHz (ITU-T) 0.02 to 23 kHz	Page 10.12			 4 10	 Hz Hz	
Residual AM rms	Page 10.12			0.02	%	

Parameter tested	Contained in	Min. value	Actual value	Max. value	Unit	Tolerance limit
Level						
Frequency response at 0 dBm	Page 10.13			0.5	dB	
Total level error >-127 dBm (temperature range 20 to 30°C)	Page 10.13			± 0.8	dB	
Output impedance SWR	Page 10.15			1.5		
Setting time for f>100 kHz	Page 10.16			10	ms	
Non-interrupting level setting	Page 10.18	Tested				
Overvoltage protection	Page 10.18	Tested				
Internal modulation generator						
Level accuracy at f = 1 kHz	Page 10.19					
3 mV		2		4	mV	
10 mV		9		11	mV	
100 mV		98		102	mV	
1 V		0.989		1.011	V	
4 V		3.959		4.041	V	
Frequency response up to 500 kHz, level >100 mV	Page 10.19			0.5	dB	
Frequency accuracy	Page 10.20			0.24	%	
Distortion f <100 kHz, level 1 V, 4 V, load 600 Ω	Page 10.20			0.1	%	
Amplitude modulation						
Deviation setting at 1 kHz	Page 10.20					
Modulation depth 1 %		0		2	%	
30%		27.8		32.2	%	
80%		75.8		84.2	%	
Frequency response	Page 10.20			3	dB	
Distortion at 1 kHz	Page 10.21					
Modulation depth 30%				1	%	
Modulation depth 80%				2	%	
Synchronous residual PhiM at AM 30%, AF = 1 kHz	Page 10.21			0.2	rad	

Parameter tested	Contained in	Min. value	Actual value	Max. value	Unit	Tolerance limit
Frequency modulation						
Deviation error RF 1 GHz, AF 1 kHz, deviation 100 kHz	Page 10.21	96		104	kHz	
Distortion RF 1 GHz, AF 1 kHz, deviation 500 kHz	Page 10.22			0.2	%	
FM frequency response	Page 10.22				dB	
Standard bandwidth 10 Hz to 100 kHz				3	dB	
Residual AM at FM, AF=1 kHz, deviation 40 kHz	Page 10.23			0.1	%	
Stereo modulation						
Crosstalk attenuation AF 1 kHz	Page 10.24			50	dB	
S/N ratio AF 1 kHz	Page 10.25					
unweighted, rms				70	dB	
weighted, rms				70	dB	
Distortion AF 1kHz	Page 10.24			0.2	%	
Phase modulation						
Deviation error RF 1 GHz, AF 1 kHz, deviation 5 rad	Page 10.25	4.78		5.22	rad	
Distortion RF 1 GHz, AF 1 kHz, deviation 5 rad	Page 10.26			0.2	%	
PhiM frequency response	Page 10.26			2	%	
Standard bandwidth 10 Hz to 100 kHz				3	dB	
Bandwidth 10 Hz to 500 kHz				3	dB	
Pulse modulation (option SML-B3)						
On/off ratio	Page 10.27			80	dB	
Rise time	Page 10.27			20	ns	
Fall time						
Video crosstalk	Page 10.28			30	mV	

Parameter tested	Contained in	Min. value	Actual value	Max. value	Unit	Tolerance limit
Stereo modulation (Option SML-B5)						
Frequency response	Page 10.13			see datasheet	dB	
Distortion and channel separation	Page 10.29			see datasheet	% dB	
Signal to noise ratio	Page 10.30				dB	
Audio deviation Pilot tone deviation, RDS subcarrier deviation	Page 10.31			see datasheet 2.5 2.5	% % %	
Preemphasis	Page 10.31			6.0	dB	
Digital S/P DIF interface	Page 10.31				%	
RDS Function	Page 10.32			0.5 2.5 yes / no